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ABSTRACT

The need to integrate technology and liberal arts in the undergraduate curriculum is addressed in this collection of two articles and a bibliography. The monograph resulted from a project by the Council of Independent Colleges on the response of the liberal arts college to technology. In "Technology and the Liberal Arts," Allan Pfnister considers the nature of technology and its impact on contemporary life and the relationship between technology and the traditional liberal arts disciplines. He considers whether the problem-solving approach of technology is a special kind of methodology and how this methodology relates to liberal learning. Robert Lisensky's article, "Technology as Subject Matter," discusses the incorporation of technology into the liberal arts curriculum. Results of a survey on current programs in technology in small liberal arts colleges are presented, along with three case studies of colleges that have altered their curricula in the area of technology. Finally, Sharon D. Sweet's selective bibliography of readings in technology and the liberal arts is presented, with ratings of the relative importance of each publication. Each of the three sections (books, journal articles and syllabi readings) are categorized by topic. (SW)

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THE NEW LIBERAL LEARNING

Technology and the Liberal Arts

This project was made possible by funding from CAPHE—the Consortium for the Advancement of Private Higher Education, and the Ford Foundation

by

ROBERT P. LISENSKY • ALLAN O. PFNISTER • SHARON D. SWEET

THE COUNCIL OF INDEPENDENT COLLEGES

PREFACE

No longer merely an idea, the technological society has become a dominant force in our nation today. The evolution and rapid expansion of technology has resulted in the creation of vast, complex systems that affect the very way we live.

In one sense, technology can be seen as a tool to extend our powers of perception and creation. But it is much more. As co-authors Robert Lisensky and Allan Pfnister state in the monograph, "Technology is not only a process of designing and creating, but also a way of knowing." Technology is a *mode of inquiry*, an action-oriented, interactive process that uses an array of critical skills—including quantitative reasoning, decision making, and the understanding of systems.

The rise of the technological society has special consequences for American higher education, and particularly the education of undergraduate students. Edward Friedman, of the Stevens Institute of Technology, observes that students must learn to deal with "complex problems at the boundaries where technology and society interact." This requires that undergraduate students study technology along with the natural and social sciences and the humanities.

It is precisely because of the need for educators to rethink and refocus the traditional liberal arts curriculum that the authors call for a "new liberal learning"—a liberal arts curriculum that includes the study of technology as a mode of inquiry *equal to* the traditional methods used in science and the humanities. Indeed, as Robert Lisensky observes, technology may well be the key link between these traditionally divergent disciplines: providing the "how to," technology can bridge the gap between the scientist's observation of "what is" and the humanist's vision of "what ought to be."

The integration of technology and liberal arts in the undergraduate curriculum is a high priority of the Council of Independent Colleges (CIC), the sponsor of this monograph. The monograph resulted from CIC's first project in the area, a survey and assessment of the response of the liberal arts college to technology and recommendations on what directions future efforts should take.

In the first essay, Allan Pfnister, vice chancellor for academic affairs at the University of Denver, explores the nature of technology and its impact on contemporary life and discusses the relationship between technology and the traditional liberal arts disciplines. In the second essay, Robert Lisensky discusses "Technology as Subject Matter," showing how it can be introduced and incorporated into the liberal arts curriculum. The third part of the monograph is a selective bibliography of readings in technology

and the liberal arts. Sharon Sweet of the University of Denver spent a year compiling the list of titles, which she rates according to their relative importance in the literature.

The project and monograph were made possible by grants from the Ford Foundation and the Consortium for the Advancement of Private Higher Education (CAPHE). We are indebted to Michael O'Keefe at CAPHE and Alison Bernstein at the Ford Foundation for providing financial support, as well as considerable personal contributions in helping CIC shape its concept of "the new liberal learning."

A panel of distinguished educators contributed significantly to the project by helping develop its scope and direction. For their assistance, we are deeply indebted to Louis Almen, president of Thiel College; Edward Friedman, vice president for academic affairs at Stevens Institute of Technology; Edie Goldenberg, associate professor of political science and public policy at the University of Michigan; J. Paul Hartman, assistant dean of the college of engineering at the University of Central Florida; Margaret MacVicar, the Cecil and Ida Green Professor of Education at M.I.T.; and Stephen Weiner, provost and dean of the faculty at Mills College.

A word of special thanks must be given to Robert Lisensky, formerly executive vice president of CIC and presently vice president of NCHEMS Management Services, Inc. His intelligence, keen insight, and commitment to excellence are evident throughout the monograph.

Gary H. Quehl
President
The Council of Independent Colleges
Washington, DC
August 1985

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CHAPTER 1

TECHNOLOGY AND THE LIBERAL ARTS

Allan O. Pfnister

The curriculum of the American liberal arts college has been, as Frederick Rudolph observes, "an arena in which the dimensions of American culture have been measured." As such, it has been subject to the same pressures that have come to bear upon the society of which it is a part—to the changes in values, perceived needs, occupational and life patterns, as well as the continuing expansion of the store of knowledge which forms and is formed by the educational enterprise itself. Confronted by the changes in society, the colleges have had to work out their own adaptations. The results have been "uneven and diverse, imaginative and pedestrian" (Rudolph, p. 3). But changes there have been, constant changes—sometimes conscious and sometimes unconscious; sometimes gradual and at other times sudden; sometimes accidental and sometimes intentional.

Among the pressures that American society (and indeed, world society) faces in the last decades of the 20th century is the need to deal intelligently and responsibly with the results of its own rapidly developing technology. Because the need to deal intelligently and responsibly with technology has consequences for American society as a whole, it has special consequences for educational systems.

The purpose of the discussion that follows is to explore possible consequences for a particular segment of the educational system, the liberal arts college. The discussion is divided into two parts, each of which includes three subtopics. The first part addresses the place of technology in contemporary life and includes three subtopics: (1) The impact of technology on contemporary life; (2) The nature of technology; (3) Issues growing out of developments in technology. The second part addresses the possible place of the study of technology within the liberal arts curriculum; (1) Is technology properly a part of liberal learning? (2) What are the key concepts in technology? (3) Is the problem-solving approach of technology a special kind of methodology and what is the relation of this methodology to liberal learning?

TECHNOLOGY AND THE CONTEMPORARY WORLD

1. The Impact of Technology on Contemporary Life

I begin this part of the discussion with three references, two of them personal. For the first, I return to an event early in 1984. Shortly after noon on February 2, 1984, my physician informed me that I had a large tumor

attached to the pituitary gland which had rendered the gland nonfunctional, and that major surgery must be undertaken at the earliest possible time. I had been taken to the hospital three days earlier following nearly total collapse. The three days had been filled with batteries of tests, culminating in the computerized axial tomography, or CAT scan, on the morning of the 2nd.

Because of the size and position of the tumor, it was decided that chemical therapy should be attempted to reduce the size, even if slightly, to increase my chances; an endocrinologist had initially characterized the tumor as inoperable because of the possible damage to brain and adjoining structures. The therapy proved ineffective. I returned to the hospital and went into surgery the morning of March 19. The operation took nearly seven hours, double the predicted time. During surgery an anesthesiologist maintained the proper level of anesthesia, while temperature, pulse, respiration and blood pressure, as well as the electrocardiograph, were monitored electronically. Meanwhile, the surgeon made the series of incisions to reach the sella turcica, a cup-like structure enfolding the pituitary and separated from the brain by a thin but tough membrane. Working with an operating microscope, the surgeon employed a curette, a small scraping tool, and suction, to remove the tumor bit by bit. In the process, the pituitary itself was removed. Since the pituitary controls the actions of many other glands, my survival depends on daily replacements to maintain the hormonal balance my body is incapable of providing. But the various medications prove to be powerful substitutes. Two weeks after the operation I was again meeting classes.

My second illustration is drawn from my early years on a farm in southern Illinois. Our four-room frame house was heated by a wood-burning stove. Food was prepared on another wood-burning stove with a cast-iron top. We carried water from a well 300 yards from the house. All the tillable land, some 80 acres, had been wrested from a forest of oak, hickory and cottonwood. Cultivation was done with the aid of three horses, hitched together in various configurations At an early age I had my chance to prove whether I could plow a straight furrow.

The 80 acres were more than enough to keep my grandfather working from morn to night. Now, massive machines—each costing many times the original price of our entire farm—turn whole sections of land into rows of corn, wheat and soybeans.

For my third illustration I observe how we attend meetings thousands of miles from home, covering the distance in a few hours. En route, we can listen to the air traffic controllers guiding our aircraft to the appropriate altitudes and direction changes as it moves from sector to sector. When we disembark, it is at a gate often designated before we boarded the plane. We enter a terminal, retrieve our luggage and take some other form of transportation to our final destination.

Throughout the journey we have been served by complex sets of overlapping *systems;* beginning with the system for the craft in flight; requiring the system that organizes and maintains the airport and all of its

equipment, and finally directed by a system of ground transportation that links the airport to the many destinations we seek.

In each of the three illustrations there are certain tools, techniques, knowledge, resources and systems that have enabled us to extend human capabilities in extraordinary ways to deal with the challenges of our environment. New tools, techniques and knowledge led to the diagnosis and instrumentation that increased my chances in a sensitive operation. Highly specialized machines, new kinds of seeds and pesticides make farming less vulnerable to the whims of nature and lead to significant increases in agricultural productivity. Modern telecommunications and transportation systems expand our ability to communicate and to participate personally in a wide range of activities in distant places.

In the processes that created and employ these tools, techniques, knowledge, resources and systems, we are witnessing the impact of technology on our contemporary world. We use the term "technology" to identify the tools and techniques of surgery, the advances in agriculture, the maintenance of commercial air transportation.

What do we mean by this term so widely and familiarly used? There is probably little agreement about how "technology" should be defined, but I find three more or less distinct applications: (1) We refer to specific tools that extend our human capabilities—tools such as the computer, laser, CAT scan, operating microscope. (2) We refer also to *systems* within which these tools are used—information technology, agricultural technology, transportation technology. (3) And, in a third sense, we refer to some generic approach to the management of our environment either as the application of technology, or more simply, as technology.

2. The Nature of Technology

What is the nature of technology? Etymologically, the roots are to be found in the Greek *techne* and *logos*, with the former referring to an "art" or "craft" involved in constructing something, and the latter implying the understanding or the logic of that craft or skill.

Thus, technology includes the tools, instruments, machines, or technical formulae developed. It includes the body of ideas expressing the intent of effort, its functional importance and rationale. And it includes the *systems* within which skills, tools, and ideas are employed.

Essentially, technology is a way of expanding the human powers of perception, reasoning, invention, and production. In this sense, for example, computer technology amplifies and emancipates the power of the brain in the same way that other technologies amplify and emancipate the power of the muscle.

Computers attached to appropriate sensors are able to detect and track moving objects with radar, to sense the proximity of metallic objects,

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to see temperature differences in objects without touching them, to detect astronomical objects and events. Motion and direction sensors guide satellites and airplanes in feedback loops which make otherwise inhumanly complex tasks manageable for human beings.

Indeed, through technology, of all known species of life, man alone has developed the means by which to transcend the physical limitations of one's body (Teich, p. ix). Perhaps the meaning of technology can be summed up in the following statement:

> **TECHNOLOGY IS A SOCIAL PROCESS THAT EMPLOYS SCIENTIFICALLY- AND EMPIRICALLY-BASED TOOLS, TECHNIQUES, KNOWLEDGE, RESOURCES AND SYSTEMS TO AFFECT THE HUMAN ENVIRONMENT AND ITS ORGANIZATION**

Technology is preeminently a *social process*, and is not to be thought of as something affecting humanity from without. Rather, technology is a process employed by humanity, a social process that draws upon knowledge and resources to create tools, techniques and systems to cope with and in some ways to alter the human environment and its organization.

It has been said that the human being is by nature a technological animal and to be human is to create tools to extend one's capability (Florman, p. 58). The human being is certainly more than a tool-creating animal, but by employing tools, we *have* altered our environment, both physical and intellectual. We have been transforming our lives since the invention of the first tools. Simple machines—the lever, pulley, inclined plane, screw, wheel and axle—are instruments that have allowed human beings to accomplish more work and to do different kinds of work more effectively and more efficiently. The simple machines, in turn, have led to the creation of more complex combinations, each development expanding even more the potential we have as human beings.

3. Issues Growing Out of Developments in Technology

We are more than tool makers, and because we are more, we have become increasingly aware of and concerned about the way we have been transforming our lives over the past decades. Technology has added new dimensions and brought many changes to our lives. And, we are becoming aware of the increased tempo with which all of this is happening.

Within the lifetime of individuals born after the beginning of the 20th century, the changes have been staggering. In 1900 there were few automobiles or household telephones. Household radios, airplanes, television and computers, now commonplace, did not exist. We continue to experience change in every aspect of our lives—in medicine and public health,

in agriculture and food supply, in transportation and communication, in social organization, activity patterns; hardly an aspect is untouched (Hamburg, p. 943). The rate of innovation has become so rapid in recent years that individuals for the first time have come to think of change—rather than the traditional—as the norm. As one writer suggests (Moser, p. 147), the expectation of innovation has, as a matter of fact, become the new tradition in our techno-industrial society.

The rapidity of change has caused us to wonder: is the development out of hand?

There is a good reason for our preoccupation and concern. With every way in which we have enriched our lives, we seem also to have added to the potential problems with which we must cope. Agricultural technology enables us to increase our food supply. Medical technology has improved conditions for maintaining health and has extended our lifespan. But we now worry about the distribution of food, about the economic impact of overproduction.

We have vast sources of energy that expand our capabilities for work—but we find that these new sources also carry the threat of destruction of our way of life as we know it.

We can repair injuries to the human body, and we can even look to the possibility of preventing some defects through genetic engineering—but we are being confronted at the same time with new questions relating to life and death, to existence versus quality of life.

In this industrial-scientific culture the rapid advance of technology produces changes in social behavior as well, in customs and institutions and in the daily lives of individuals. Accompanying all of the changes and sense of strangeness is also a fear, a technophobia, born out of the suspicion that the same technology that offers so many advantages also makes it possible for the few who control developments to manipulate the many (Huxley, 1932, 1958; Orwell, 1949).

TECHNOLOGY AND LIBERAL LEARNING

1. Is Technology Properly a Part of Liberal Learning?

That we live in a world characterized by a "rapid, pervasive, truly unprecedented transformation resulting from science" is a central fact of life; and, that there is "little in our history as a species to prepare us for this hypermodern world that we have so rapidly made" (Hamburg, p. 943), is equally clear. It is in this hypermodern world, however, that we and our students live. It is the hypermodern world to which we must respond, with which we must cope, and to which we must contribute in the most constructive ways. For institutions that presume to prepare students for meeting the

problems and concerns of their world, the responsibility seems clear. At the very least we need to create opportunities for objective and scholarly analyses of the critical issues growing out of the developments in technology. For liberal arts colleges with their avowed emphasis upon value-centered education, opportunities must be created for students to assess the possible moral and social implications of our technology.

Higher educational institutions cannot "in good conscience claim to be educating persons today in the liberal arts, preparing them to be strong and critical and whole human beings able to make judgments about things that impinge most crucially on their lives, unless we include the phenomena of technology (Kehane, 1982). The study of technology joins the more traditional aspects of liberal education if for no other reason than technology is a dominant force in contemporary life. We need to study technology because we are surrounded by it (Kranakis, p. 1). If we expect our graduates to contribute to the quality of life through their individual creative work in family, jobs and society, we need to recognize that all of us are involved in and interact with a highly technological environment, and that "education should develop his/her capability for lifelong learning in all of the disciplines which contribute to that environment" (Truxal, p. 2).

In short, the study of technology has a legitimate place in the liberal arts curriculum, not just for the few who look forward to a professional life in science and technology, but for all students who consider themselves liberally educated. Technology has so shaped our lives, and will continue to do so. Just as we have in the past demanded of a liberally educated person a sense of society, its development and the forces working upon it through historical, sociological, economic and ethical perspectives, we must ask that the liberally educated person in the last part of the 20th century become acquainted with forces that have assumed overpowering importance in the shaping of that society.

The Greeks, from whom we derive so many of our ideas about civilization, have provided a term which can be transliterated *encyclios paideia* and which was applied to the progressive educational experiences of the citizen. At the very least, the concept contained the sense of acculturation, the incorporating of values of one's society, of being able to conduct oneself as an effective member of one's society.

The Greek *encyclios paideia* was identified with the Roman *ars liberalis* by Posidonius, an important Greek stoic philosopher of the late second and early first century B.C., when he equated the *encyclios* of the Greeks with the *liberalis* of the Romans, or the arts of the *encyclios* with the Roman "liberal arts" (Gynn, p. 88). By the first century, however, the ancient *encyclios paideia* was in decline, and the Roman view of education was in the ascendancy. The Greek concept of acculturation was being transformed by the Romans into preparation for professional life. Over time the Roman version of the "liberal arts" became more or less standardized and was carried into Western Europe through Martianus Capella (c. 410 A.D.) in the allegory

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of the "Marriage of Mercury and Philology" in which the seven liberal arts are described. Subsequently, Cassiodorus (477–565 A.D.) effected an even more significant shift in the nature and function of the liberal arts in Western education.

Having held positions of responsibility under Theodric the Great, Cassiodorus retired to a monastery which he had founded and organized according to the Benedictine rule. There, he played a significant role in fostering the preservation of secular as well as ecclesiastical knowledge among the monks, giving the Benedictines the impulse to intellectual work for which they were distinguished in medieval times.

It was he who found Scriptural sanction for making the study of the seven liberal arts the appropriate preparation for the study of theology, and he urged the monks to prepare for their vocation through the systematic study of the arts.

But Cassiodorus was also responsible for making more precise a distinction between the lowly arts and the liberal arts. In spite of the fact that he himself had a knack for mechanical inventions and occupied himself with developing sundials and water clocks, he argued for making a clear division between works of the mind and works of the hand. For Cassiodorus, the liberal arts were not preparation for being an effective citizen but the training of the mind for the study of theology—not preparation for life, but a formal sequence that turned away from the world of work and experience and was focused on professional intellectual activities. This concept of the liberal arts dominated much of the education of Western Europe and entered American culture in the first colonial colleges.

In a sense, the colonial colleges were also preparatory institutions; there was no higher or advanced study to which graduates might go. Liberal education as provided by these institutions only set the stage for subsequent training in the pulpit, in the law office, in the political arena. The role of the college was to provide the basic knowledge and skill that would enable the graduate to enter with reasonable assurance into any one of these vocations. From the beginning, the New World colleges might have tried to emulate monastic life in the spirit of Cassiodorus, but the world of the mind and the world of work were not that easily separated. The American college could never remain static in its treatment of the liberal arts. Indeed, most of the 19th century, when American higher education began to expand with the nation, was devoted to debating the proper distribution of the elements of liberal education in a responsible and responsive collegiate institution.

The debate about what properly constitutes liberal education continues, but in much of the current discussion the emphasis is upon equipping one to cope successfully with the modern world. This is the theme of an essay of Kenneth R.R. Gros Louis:

> For me, training in vision, providing a general education in all the connotations of the word *vision*, suggests possible new emphases, each to be adapted to the uniqueness of an

> institution. General education enables people to see clearly, to have the ability to examine issues and people as objectively as possible, without bias or prejudice, preconceptions or stereotypes; to examine nature and natural phenomena with complete freedom. It means having the vision to see complexly, recognizing nuances of expression, subtle shades of color . . . It means having good enough vision to see far—far into the past, knowing where we have come from, how we have developed as a people, how our values have been shaped and determined, in what ways we are like and unlike our predecessors and ancestors; it means good enough vision to see far into the future, to know how to analyze trends and foreshadowings, how to identify and assess the factors, scientific and nonscientific, that will do much to create our future . . . [pp. 34-35].

If one substitutes the words "liberal arts education" for "general education," the "vision" that Gros Louis describes is the kind of vision that the educated citizen has needed in the past and needs in the present. Such vision, in the context of the knowledge and skills of liberal education, sets the task for the liberal arts colleges in the 1980s and the future.

Liberal education means knowledge—verifiable knowledge about the world of nature and its processes, knowledge about human society and its historic origins and its ever-changing contemporary forms. It means also trained skills and abilities, skill to use one's knowledge effectively (and the use of one or more foreign languages adequately), the ability to think critically and to judge intelligently among alternatives, the ability to participate helpfully in social situations. It means appreciation of people and recognition of the moral and spiritual quality of actions (Schmidt, pp. 241-242).

The components of the educated person in this hypermodern world are knowledge and skill and vision capable of dealing with the complex contemporary world and the ability to anticipate something of the shape of the future—and technology is part of the subject matter.

2. Key Concepts in Technology

Technology as a social process employs scientifically and empirically based tools, techniques, knowledge, resources and systems to affect the human environment and its organization. In discussions of technology, one finds the terms science *and* technology used in combination, as if the one cannot be considered without the other. Historically, however, technology developed without reference to science. The social process that is technology arose empirically, either by accident or as a matter of common experience. For example, certain biochemicals (such as ephedrine, cocaine, curare and quinine) were used long before the development of science. Certain industrial

processes (cheese making, fermentation, tanning) developed in the absence of science. In the Middle Ages technology ran far beyond the very limited scientific knowledge of the times. Agriculture had adopted the rotation of crops. The Saxon wheeled plough was invented, enabling the heavy fertile soils to be cultivated. The windmill was constructed, and by the time of the Norman Conquest some 6,000 water-wheels were in use in England. In the following centuries water power was applied to a variety of processes—sawing wood, forging iron and grinding corn. The crank was introduced, and improvements were made in the processes of transmitting power. The spinning wheel was invented and was to have a significant impact much later, in the 18th century. The weight-driven clock and the printing press were invented, "so fundamental that they still condition our lives in ways and to an extent that few other inventions have done" (Cardwell, pp. 9ff).

Technology as a kind of instrumental knowledge long existed without technology. In Greek physics one had the rudiments of science without the technology. In Roman engineering one had the technology without the science. Even in the contemporary world we continue doing things without understanding how. We know many processes, such as the fusion of helium out of hydrogen, which we are not able, at least at the present time, to control for useful purposes (Bunge, p. 67).

Sometimes the distinction between science and technology is stated in the form that science is concerned with "knowledge discovered, and being discovered," while technology is "knowledge created, and being created" (Gies, p. 17). Such a distinction is probably an oversimplification, but the sense conveyed is that science is detached, concerned about knowledge for its own sake, while technology is more directly involved in the social process and is concerned about the solution of problems and application of knowledge to that solution. Both scientist and technician may employ experiment, but the scientist is guided by hypotheses deduced from theory, while the technician, or the technologist, may employ trial and error or skilled approaches derived from the concrete (Feibleman, p. 36). In many instances technological advances are based on pure science, on the theoretical foundations of physics and chemistry, but the problems investigated in technology are technical, and the solutions are not in terms of increasing knowledge as such but in solving a technical problem (Skolimowski, p. 44). In science one is concerned with reality and its basic meaning; in technology one produces artifacts, developing objects according to specifications.

What then is the essence of "technology" as related to "science"? References to "technology" tend to be in combination with other words such as "application," "tools," "artifacts," "practice," "effectiveness," "empirical laws," "instrumental principles." In contrast, the term "science" is used with such words as "theory," "theoretical principles," "research," "generalization from theory," "improvement of theory."

Early technologies were responses to perceived needs, solutions to immediate problems, and as noted above, without any particular

theoretical base. Science developed in response to another set of questions relating to the nature of reality itself. In the contemporary world, however, the two have become so intertwined and interdependent that the relationship is more symbiotic than ever before. Contemporary science is dependent on the tools that technology has been able to create. A bewildering array (at least to the layperson) of electronic devices enables the scientist to measure, to image, to discover and to control even subatomic particles. Without these products of technology modern science as we know it would be impossible. On the other hand, the discoveries of science prompt and enable technologists to develop still newer and more refined tools for measuring, imaging, discovering and controlling.

For a college developing courses relating to technology, those participating need some knowledge of the science involved or would need to work with a science-based person. At the same time, however, the nature of technology as a social process requires that the science-based person have input from other disciplines as well.

We return then to our definition of technology as a social process that employs scientifically and empirically based tools, techniques, knowledge, resources and systems to affect the human environment and its organization. Technology derives its impetus from the requirements of society and proceeds on the basis of scientific *and* empirical tools, techniques, knowledge and systems.

3. A Methodology to be Emphasized?

Although perhaps not wholly unique to the technological approach, there is a methodology associated with technology that ought to contribute to the skills that we like to think are characteristic of the liberally educated person. Technology is action oriented, and this orientation conditions the way in which technology deals with problems.

Technology participates in events. A premium is placed on intervention, and intervention calls for forecasting the probability that a given type of action will achieve a preselected goal. In contrast to the prediction of science, which indicates what will or may happen if certain circumstances occur, technological forecast suggests how to influence circumstances so that certain events may be brought about or prevented, and that would not happen in the normal course of events. Thus, it is one thing to predict the orbit of a comet, and quite another to plan and foresee the trajectory of an artificial satellite (Bunge, p. 72).

In seeking adequate means to accomplish goals, technology must be involved constantly in studying means-ends relationships. And, whereas science seeks to remain separate from what is being investigated, technology necessarily is placed within the system concerned. It is the dif-

ference, for example, between forecasting a landslide and designing and supervising appropriate defense works in an effort to prevent a landslide.

Technology involves intervention. Indeed, by definition, it *is* intervention. It is a form of intervention that employs tools, techniques, knowledge, resources and systems for the purpose of affecting the human environment and its organization. Intervention carries with it accountability. First, there is accountability for the immediate consequences of the intervention: Was the goal achieved? For example, does the new communication system work? Does it enable members of the organization to contact one another more efficiently? Second, does the intervention have indirect consequences? Does the new communication system affect the behavior of users? Does it change their mode of interaction with one another? Are there unexpected consequences? Does facilitation of communication weaken personal relationships rather than improve them? Is there a positive or adverse effect on work-flow? And third, does the introduction of the technology raise new ethical questions? Can the communication system be abused? Can it be used to control the behavior of others?

The widespread introduction of the computer may be a case in point. Computers are used in almost every realm of contemporary life—in business, the arts, medicine, industry, education, to name but a few. That the computer facilitates the accessing and use of information can hardly be debated. But what of the potential loss of privacy arising from the development of mass data banks? Or the elimination of some jobs and the creation of others by developing technology—with the consequences for the persons directly affected? What about the impact of computer technology on organizational structure in the dissipation of hierarchies, given the computer's capability to keep detailed track of people and business information? What is the impact of the computer on the way we think and the language we use?

The recognition of technology as intervention brings into the study of technology, particularly in the liberal arts college, an existential element. In the applications of this social process called technology, it is important that one knows enough about the nature of technology and the implications of intervention to be able to participate as an effective decision-maker in the society in which technology plays such a large part. The expanding presence of technology as a particular form of intervention brings with it the importance of our understanding the underlying concepts of technology, "concepts which lead to the characteristics, capabilities, and limitations of the machines and systems. If our educational system is to prepare students for the richest possible life, we must guide them toward the use of the technology for their own benefit" (Truxal, p. 4).

To understand technology, one must have some grasp of the concepts, modeling techniques and problem-solving modes that have been developed by technological decision-makers. Important ingredients in assessing the effects and evaluating the consequences of technological intervention

are the ability to construct complex systems and to evaluate these systems in a structured fashion through modeling and step-wise probing. Referring to engineering and medicine as examples, Friedman (1980, p. 2) observes how both are faced with decisions that involve risk and must be made with incomplete information. Uncertainty and ambiguity are built into the everyday practice of these professions.

For the liberal arts student, the process of analysis as well as the appreciation of the extent to which many of life's decisions must be made in an atmosphere of ambiguity and with incomplete information are important components of education. Technology focuses on decision making, on defining what needs to be done, on modeling so that quantitative as well as qualitative studies can be made, on trying out the model, on matching the results with the reality from which the model was derived, and on designing something that could improve conditions (Bordogna, p. 10).

The approach of technological problem-solving may be described also in terms of system analysis—modeling, predicting, developing probability models, simulation optimization, undertaking benefit/risk analysis (Truxal, pp. 10–11). Modeling requires the ability to decide what elements to include in dealing with a problem. Prediction sets the limits within which the problem is to be solved. Probability models in an intervention approach project what *might* happen in the light of known circumstances. Optimization involves selecting the best options, given the known constraints. In benefit/risk analysis one tries to anticipate the range of consequences of a given intervention.

In summary, the methodology or approach of technology includes at least the following elements:

1. Is action-oriented, requires intervention.
2. Requires consideration of ends-means relationships.
3. Suggests accountability growing out of intervention.
4. Is existential, touches the way of life directly.
5. Involves such important concepts as modeling techniques, problem-solving modes in conditions of ambiguity and uncertainty in understanding the complexity of systems, prediction, optimization.

While these analytical approaches are not exclusive to technology, the involvement in technology and the effort to understand technology demand that one engage in the kind of thinking expected of the liberally educated person. What may be an additional (and important) element is the emphasis upon intervention. Technology is action-oriented and demands intervention to affect the human environment and its organization. Analysis, for example, is for the purpose of developing tools, techniques, knowledge, resources and systems that solve or contribute to the solution of human problems.

And thus it is that technology as subject matter is an important element in the education of the citizen decision-maker in the contemporary world. Technology as an approach to dealing with the human environ-

ment draws upon the form *and* substance of liberal education and contributes to the liberal education of the citizen in the contemporary world.

REFERENCES

1. Abelson, Philip H., and Mary Dorfman (Issue editors). "Computers and Electronics," *Science*, Vol. 215, No. 4534 (February 12, 1982).
2. Angus, Ian H. *Technique and Enlightenment: Limits of Instrumental Reason* (Washington: Center for Advanced Research in Phenomenology and University Press of America, 1984).
3. "An interview with Manfred Stanley: Technology, Society and Education." *The Antaeus Report*. From the Center for the Study of Education and Society (Fall, 1982) Ohio Wesleyan University, 2–6.
4. Baier, Kurt, and Nicholas Rescher (eds). *Values and the Future: The Impact of Technological Change on American Values* (New York: The Free Press, 1969).
5. Boorstin, Daniel J. *The Republic of Technology* (New York: Harper and Row, 1978).
6. Bordogna, Joseph. "Technological Literacy: Technology as a Liberal Art." Paper prepared for Sloan Foundation Conference, April 1984.
7. Botkin, James W., Mahdi Elmandjra and Mircea Malitza. *No Limits to Learning: Bridging the Human Gap* (Oxford: Pergamon Press, 1979).
8. Braudel, Fernand. *The Structures of Everyday Life: Civilization and Capitalism 15th–18th Century*, Vol. 1 (New York: Harper and Row, 1979)
9. Cardwell, D.S.L. *Technology, Science and History* (London: Heinemann Educational Books Ltd., 1972).
10. Chen, Kan (ed). *Technology and Social Institutions* (New York: IEEE Press, 1974). Papers presented at an Engineering Foundation Conference May 20–25, 1973, with support from the National Science Foundation.
11. Deken, Joseph. *The Electronic Cottage* (New York: William Morrow and Co., 1982).
12. Ellul, Jacques. *The Technological Society* (New York: Vintage Books, 1964).
13. Evans, Christopher. *The Micro Millennium* (New York: The Viking Press, 1979).
14. Feibleman, James K. "Pure Science, Applied Science and Technology: An Attempt at Definitions." Mitcham and Mackey, 33–41.
15. Feibleman, James K. *Technology and Reality* (The Hague: Martinus Nijhoff Publishers, 1982).
16. Feinberg, Walter. *Understanding Education: Toward a Reconstruction of Educational Inquiry* (Cambridge: Cambridge University Press, 1983).
17. Ferkiss, Victor C. *50: Futurology: Promise, Performance, Prospects* (Beverly Hills: Sage Publications. 1977).
18. Florman, Samuel C. *The Existential Pleasures of Engineering* (New York: St. Martin's Press, 1976).
19. Friedman, Edward A. "Technology and Higher Education in America for the Next Decade," *Liberal Education*, 65, 198–205.
20. Friedman, Edward A. "Technological Literacy and the Liberal Arts," *The Forum for Liberal Education*, III (December 1980), 1–3.
21. Gies, Joseph C. "Technology: A New Liberal Arts?" *AGB Reports*, 24 (January/February 1982), 17–20.
22. Goulet, Denis. "Science and Technology for a Global Society." *Impact of Science on Society*, 1983, No. 2, 179–188.
23. Gros Louis, Kenneth R.R. "General Education: Rethinking the Assumptions," *Change*, 13 (September 1981), 31–36.
24. Gynn, Aubrey. *Roman Education from Cicero to Quintilian* (New York: Teachers College Press). Classics in Education, No. 29. Originally published by Oxford University Press in 1926.
25. Haberer, Joseph (ed). *Science and Technology Policy* (Lexington, Mass.: D.C. Heath and Company, 1977.).
26. Hamburg, David A. "Science and Technology in a World Transformed." *Science*, 224 (June 1, 1984), 943–946.

27. Harrison, Anna J. "Reflections on Current Issues in Science and Technology," *Science*, Vol. 215 (February 26, 1982), pp. 1061–1063.
28. Hawkridge, David. *New Information Technology in Education* (London: Croom Helm, 1983).
29. Johns, E.A. *The Sociology of Organizational Change* (Oxford: Pergamon Press, 1973).
30. Jordan, Hans. "Technology as a Subject for Ethics," *Social Research* 49 (Winter, 1982) pp. 891–898.
31. Kranakis, Edna Fowlks. "Technology and the Liberal Arts." Paper prepared for Sloan Foundation Conference, April 1984.
32. Kuhn, Thomas S. *The Structure of Scientific Revolutions* (Chicago: The University of Chicago Press, 1970).
33. Loscerbo, John. *Being and Technology* (The Hague: Martinus Nijhoff Publishers, 1981).
34. Macdonald, Stuart, D. McLamberton and Thomas Mandeville (eds). *The Trouble with Technology: Explorations in the Process of Technological Change.* (London: Frances Pinter Publications, 1983).
35. McNeil, B.J., and E.G. Cravalho (eds). *Critical Issues in Medical Technology* (Boston: Auburn House, 1982).
36. Mitcham, Carl, and Robert Mackey. *Philosophy and Technology* (New York: The Free Press, 1972).
    Bunge, Mario. "Toward a Philosophy of Technology," Mitcham and Mackey, 62–76.
    Jarvie, I.C. "The Social Character of Technological Problems: Comments on Skolimowski's Paper," Mitcham and Mackey, 50–53.
    Skolimowski, Henryk. "The Structure of Thinking in Technology," Mitcham and Mackey, 42–49.
37. Moser, Leo J. *The Technology Trap: Survival in a Man-Made Environment* (Chicago: Nelson-Hall, Inc. Publisher, 1979).
38. Murthy, K.K. "Man, Technology and the Natural Holism," *Impact of Science on Society*, 30 (April–June 1980), pp. 80–85.
39. Petroski, Henry. "Technology is an Essential Component of Today's Liberal-Arts Education," *Chronicle of Higher Education*, November 14, 1981, p. 88.
40. Piel, E.J., and J.C. Truxal. *Man and His Technology: Problems and Issues* (New York: McGraw-Hill Book Company).
41. Rudolph, Frederick. *Curriculum: A History of the American Undergraduate Course of Study Since 1636* (San Francisco: Jossey-Bass Publishers, 1979).
42. Saxonn, David S. "Liberal Education in a Technological Age," *Science* Vol. 218, No. 4575 (November 26, 1982).
43. Schmidt, George P. *The Liberal Arts College* (New Brunswick: Rutgers University Press, 1957).
44. Scribner, Sylvia, and Michael Cole. *The Psychology of Literacy* (Cambridge: Harvard University Press, 1981).
45. Smalley, Lee (ed). *Technological Literacy.* Technology Education Symposium II, University of Wisconsin-Stout, Menomonie, Wisconsin (Menomonie, Wisconsin, 1981).
46. Stanley, Manfred. *The Technological Conscience: Survival and Dignity in an Age of Expertise* (New York: The Free Press, 1978).
47. Teich, Albert H. (ed). *Technology and Man's Future* (New York: St. Martin's Press, 1972).
48. *The Techno/Peasant Survival Manual,* A Print Project Book (New York: Bantam Books, 1980).
49. Truxal, John G. "Technology in Liberal Education." Paper prepared for Sloan Foundation Conference, April 1984.
50. Tullock, Gordon. *The Organization of Inquiry* (Durham: Duke University Press, 1966).
51. Vaughan, Jerry L. "Technology and Your Future." *Viewpoints 1983,* 1–8. ERIC Document, ED 236 074.
52. Warnat, Winifred I. "The Challenge: Developing Technological Literacy in Education." Paper presented at the Science and Mathematic Education Needs Assessment Conference, Ypsilanti, Michigan, 1983. ERIC Document ED 234 012.
53. Watkins, Beverly T. "Technological Literacy Urged for Students in the Liberal Arts," *Chronicle of Higher Education*, January 13, 1982, p. 1, 11.
54. Watkins, Bruce L., and Roy Meader. *Technology and Human Values Collision and Solution* (Ann Arbor: Science Publishers, Inc., 1978).

55. Weizenbaum, Joseph. *Computer Power and Human Reason: From Judgment to Calculation* (New York: Penguin Books, 1984).
56. Wynne, Brian. "The Social Viability of Technology." *Futures* 15 (February 1983), 13–32.
57. Yff, Joost, and Michael J. Butler. *Technological Literacy* (Washington: ERIC Clearinghouse on Teacher Education, 1983).
58. Zwicky, F., and A.G. Wilson (eds). *New Methods of Thought and Procedure* (New York: Springer Verlag, 1967).

CHAPTER 2

TECHNOLOGY AS SUBJECT MATTER

Robert P. Lisensky

Curricular change in the small liberal arts college often occurs in response to changes in the culture. Today, colleges are attempting, through their curricula, to adapt to what appears to be a mismatch between their educational programs and society's values and needs. In order to meet the needs of a changing world, the liberal arts need to be sustained, reexamined and reviewed.

As Kranzberg observes, the ancient questions are still basic: "What is truth, beauty and justice? What is man's relationship to nature, to his fellow man, to the cosmos?" The old answers simply won't do. "We need a 'new liberal arts,' one which takes cognizance of the new world brought into being by the growth of science and technology and their interactions with society" (Kranzberg, p. 35).

Technology has become a dominant force in contemporary society. It affects our conception of ourselves and our reasoning, and generates complex systems that affect fundamental aspects of human existence. The educated citizen of the future—and the present—must be able to grasp and solve essential technological questions intelligently and responsibly.

Higher education is again being challenged to change. Although the need to develop a revised program pervades the total educational system, its impact will be felt most directly in the small liberal arts colleges. Liberal arts colleges traditionally have not accepted the study of technology as part of the curriculum. Historically, they have attempted to ward off specialization, vocationalism and intervention.

They have also struggled with the problems created by the expansion of programs, problems which will be especially difficult during a period of non-growth. Thus, to suggest that the small liberal arts college include the study of technology in its curriculum—in addition to, not in place of, the study of science, social science and the humanities—is to add additional pressure to a sensitive area.

What curricular adaptations have the small liberal arts colleges made in response to the technological society? When responding to the artifact world? We sought to answer these questions by: 1) conducting a survey to assess the current programs in technology in small liberal arts colleges, and 2) conducting three on-site visits to colleges that have altered their curricula in the area of technology.

We sought to identify any common themes in these programs for the benefit of those who might wish to implement programs of a similar nature. We also attempted to understand the unique role that the study of technology can play in the development of a "new liberal learning." Because

of the differences in institutional structure and the different kinds of educational outcomes colleges desire for their students, the approaches to teaching technology are, as one would expect, quite different.

COURSES IN TECHNOLOGY

Questionnaire

In an attempt to get a general idea of what courses in technology are being taught in small liberal arts colleges and how technology is perceived, the Council of Independent Colleges mailed a questionnaire to the academic deans of 718 small liberal arts colleges. The dean was asked to distribute the questionnaire to any faculty members who have taught or are now teaching courses in technology. Each faculty member was asked to fill out the questionnaire, attach a syllabus of the course and return the material to CIC. We decided to make the questionnaire quite simple (i.e., we asked only for basic information: course title, course description, student enrollment, frequency offered, prerequisite and object of course). We did not include a self-addressed envelope, so the participants had to take some initiative in order to respond. Also, we did not define "technology," for we preferred to see what responses we would get when we left the definition open-ended.

Of the 718 colleges who received the questionnaire, 195 responded. From those responses we received 343 course outlines. These were then reviewed by a committee, which included a scientist, a social scientist and an engineer educator, to determine which fit our definition of courses in technology. In compiling the list, we were interested in both technology and the liberal arts and in their coupling within courses. The courses had to include a scientific base and also deal with technology as a social process. The committee identified and listed (title, contact person, address) 99 courses that met this definition. We distributed this list to all survey participants in order to encourage networking.*

In addition, we wanted to get a general picture of what is being taught as "technology." A number of insights surfaced. We were surprised at the degree of interest in the topic. However, we also became aware that most of the courses offered were the result of interest on the part of an individual faculty member and not an institutional commitment to the concept of technological literacy. Technology is seen as an add-on and not an indispensable part of the traditional liberal arts. However, the liberal arts faculty, for whom technology represents a secondary rather than a primary interest, appear to be interested in or willing to teach courses in technology (Truxal, p. 3).

*Copies of this list are available by writing to the Council of Independent Colleges, One Dupont Circle, Suite 320, Washington, DC 20036

We also observed that courses in technology were often either science-based or social-process-based. Most often courses taught by the science faculty did not cover the nature and role of technology in society, nor did the courses taught by the social science or humanities faculty deal in any detailed way with the technical or science component. Of the 343 syllabi submitted, we classified 105 as one-dimensional in scope. It is important to stress that "to understand a technology, we must consider not only the relevant quantitative modeling and scientific base, but also the social behavior, economic, aesthetic and ethical implications" (Truxal, p. 5). These courses, however, are excellent beginning points for dealing with technology in the curriculum. Often new courses have been developed, rather than building from the strengths of existing one-dimensional courses.

A third lesson learned was that colleges understand technology to be synonymous with the computer. The major portion of the courses submitted (139 out of 343) dealt with computers, typically an introductory course on programming, hardware and software. Very few courses went beyond literacy and programming to treat the computer as a technological artifact. The commitment to computer literacy has overshadowed the more fundamental issue of technological literacy.

Case Studies

In order to observe how some small colleges have incorporated the study of technology, we visited three institutions. We chose these colleges because in their response to the questionnaire they demonstrated a strong interest in teaching technological literacy, they represented diverse institutional types, they had no engineering college attached and they had not received external funding to develop programs in technology.

The two-day visits were not an attempt to study or develop a model program but to understand what influenced the college to promote the development of a program, to determine why this particular program was developed at this institution and to learn what new directions were anticipated, if any. These three examples reflect the diversity of programs in technology and illustrate how different institutions develop different processes to achieve similar purposes.

Wartburg College—Technological Literacy

Wartburg College is a private, residential, four-year liberal arts college in Waverly, Iowa. It is co-educational with a student body of approximately 1,200. It has a 4-4-1 calendar and is affiliated with the American Lutheran Church.

The academic program includes three core courses (*Foundation Studies: Human Expression, Person and Society* and *The Natural World*) which examine the characteristic ways in which inquiry is conducted within the humanities, the social sciences and the natural sciences. Students must also take one interdisciplinary course and a capstone course. The interdisciplinary course approaches a problem or issue from the perspective of several academic areas, and the capstone course attempts to synthesize the learning experience in the student's major field.

The influence that prompted the first development of courses in technology is ascribed to the climate of the early 1970s. For example, the interdisciplinary course, *Humanity and the Environment*, is the result of a student petition for a course relating to Earth Day. The instructor reported what is often a common experience. The course began as a response to the ills of technology but now focuses on the ambiguities created by its intervention in agriculture, population and pollution. Two other interdisciplinary courses, *Problems of War and Peace* and *Futuristics*, also are responses to questions of relevance to the human condition.

The course, *The Natural World*, which was developed about six years ago and is required of all students, was developed as an interdisciplinary science course that emphasizes science rather than the sciences. The course emphasizes the scientific methodology more than the results of the methodology. A major part of the course focuses on Horace Judson's *The Search for Solutions*. The syllabus of the course states:

> Several themes besides those of scientific process and our understanding of the natural world are included in the course.
>
> One of the most important of these relates to understanding the interrelationships among science, technology and society. Misconceptions about these interactions abound in modern people and seem to come to the surface as people become more aware of the increasing dependency of science, technology and society upon each other.

The director of the program reports that one of the goals of the course is technological literacy, although he suggested that it was technology viewed as applied science. Topics covered in the course include food production, nuclear war and energy. It is hard to determine whether the interdisciplinary courses that focused on technology had any impact on the creation of this course, but the instructors in those courses shared informally in the conversations that created the course, *The Natural World*.

The capstone courses in each major field, in some cases, have also introduced technology. In the chemistry-biology capstone course, through a series of weekly seminars, an attempt is made to "examine the underlying assumptions, limitations, frontier developments, ethical dimensions and issues of science and religion/faith." Some of the papers presented in the

last seminar indicate the focus on technology. They include: Organ Transplants, The Use of Erogenic Aids in Sports Medicine, Cryonics, and Radiation Therapy in the Treatment of Cancer.

It is hard to determine why there is such an emphasis on technology at Wartburg, but certain possibilities present themselves. Wartburg has emphasized career preparation (accounting, applied music, business administration, communication arts, music therapy, social work, etc.) and thus there has been an interest in "the applied." Also, a number of faculty members have had experience in industry and related fields. This was especially true for the faculty members teaching these courses. The one thing that became evident during the visit was that the program grew out of individual faculty interests rather than an organized effort on the part of the college to deal with technological literacy. The faculty appears intent on being more comprehensive when dealing with technological literacy in the future.

The College of St. Catherine—Biomedical Technology

The College of St. Catherine, located in St. Paul, Minnesota, is a four-year liberal arts college for women. The current enrollment is approximately 2,400 students with about a third residential. One of the goals in their liberal arts tradition has been to prepare women to deal effectively with technology in their lives. The catalogue states that:

> The College believes that a literate woman, sensitive to the arts, aware of her cultural and historic heritage, at home in a world of many cultures, and effectively prepared to live in a technological society, will not only have the foundation for a satisfactory personal life, but also the potential for a significant contribution to society and the world.

Since the introduction of an Interim Term in 1971, a number of course offerings have addressed the issues of science, technology and society. The major emphasis has been in biomedical technology. These courses have evolved as a result of faculty interest and also because of the nature of the institution's commitment to the subject. St. Catherine's has had a major in nursing and a five-year program in medical technology since the 1940s and the number of the college's graduates admitted to medical and dental schools grows with each passing year. In addition, the college has recently established a Center for Ethics, Values and Responsibilities to integrate discussions of ethics into the curriculum, and to serve as an outreach program for the Twin Cities area.

The commitment to biomedical technology is also the result of the college's fortuitous setting. The Twin Cities are a major center for innovative biomedical companies (Cardiac Pacemakers, Medtronics, 3M, Marker Laboratories, Biomedicus, etc.), as well as the University of Minnesota

Hospitals and Medical School, renowned for their organ transplant program, fertility research and application of biomedical engineering.

A course in *Biomedical Ethics*, which deals with issues arising from the medical treatment of physical and mental illness, has been offered for several years. One of the objectives of the course is to become familiar with critical contemporary problems "resulting from advances in the biological sciences, and the interface of these areas with law, public policy, and religion."

A *Biomedical Technology* course is presently being developed. It will cover three key areas: cardiovascular technology, renal disease, and *in vitro* fertilization and implantation. A five-member faculty team is designing the course syllabus and plans to offer the course in the spring of 1986. A lectures series for the general public on medical technology is also in the planning stage. A list of proposed speakers and topics demonstrates clearly the need for informed citizens in this area: Dr. John Najarian, M.D., Professor and Chairman, Department of Surgery, University of Minnesota Medical School, whose topic is "The Social and Ethical Consequences of Renal Transplantation"; Professor Hugh C. Hensleigh, Ph.D., Department of Obstetrics and Gynecology, University of Minnesota, who will speak on "Ethical Problems of High Tech Motherhood"; and Earl Bakken, President, Meditronic, whose topic is "The Economics of High Technology."

In addition, other courses have attempted to prepare women to deal effectively with technology. A number of courses in the natural sciences introduce students to a wide variety of technologies. One is a beginning physics course with a laboratory section in which students construct small-scale rockets, fire them, gather data on their performance and compare the results using computer programs developed by the instructor.

Other courses may be mentioned: an interdisciplinary course, *The Art of Thinking*, which discusses "what evidence is, the organization of knowledge, thought and metaphor, the ethics of thinking and thinking as a life process," or *The Chemistry of Life* course, offered to the non-traditional student in the Weekend College, which is "designed to help students understand how chemicals impact on every facet of their lives."

However, the impact of technology on the curriculum at the College of St. Catherine seems to be just beginning. The college is presently engaged in a core curriculum revision which focuses on a set of goals-to-be-achieved rather than specific courses to be taken. Having faced the problem of a writing competency, the next area of exploration is mathematics. This issue has introduced a fresh debate about technological literacy. The proposal for a new course, *Greatest Ideas in Science*, to be offered by the physics department in the fall of 1985, perhaps best describes the conversations taking place on campus:

> It is proposed that this course will address the historical and especially the modern role of science in today's world. The processes of science will be stressed so that the student will hopefully understand what science is, how it works, what

> its limitations and capabilities are, and what kinds of expectations are realistic in today's post-industrial, or technological age. It is of utmost importance that citizens today understand certain ideas to make decisions as consumers, for leisure, etc. Importantly too, as a liberal arts discipline, one needs to be able to understand the framework of the world they live in.

Some of the ideas to be covered are special and general relativity, the nature of matter, radioactivity and cosmography and cosmology.

Kenyon College—A Traditional Approach

Kenyon College, founded in 1824, is a four-year private liberal arts college located in Gambier, Ohio, some 50 miles northeast of Columbus. The college has maintained a planned enrollment of 1,450 students, all residential. Established as a college for men, Kenyon became coeducational in 1969. The college follows a semester calendar.

The primary emphasis in the academic program is on the student's major. Study in the major "demands a significant concentration of energies in a comprehensive and disciplined investigation, challenging the student's capacities in a way that limited acquaintance with a broad array of topics cannot do." Complementary to the major is a general institutional requirement that students must earn at least nine units outside the major department. Among the nine, one unit must be earned in at least five departments distributed among four divisions. The major may be either in one department or in two or more departments.

The college catalogue states that the history of Kenyon "is of permanence within constant change, of an institution's preserving its essential character as an independent liberal arts college while adapting to an altering world." It is within this spirit of strong tradition and openness to change that Kenyon has found itself deeply involved in exploring the relationship between liberal education and the world of technology. When the CIC questionnaire was distributed, seven reports were returned from seven different departments. An eighth report referred to an interdisciplinary course team-taught by faculty from three different departments.

Only one of the courses contains the term "technology" in the title, a course in the sociology department entitled *Science, Technology, and Ideology*, but all of the courses deal with the nature and impact of technology. In *Science, Technology, and Ideology*, the outline includes topics such as "Science and the Logic of Inquiry," "How and What Does Science Know?," "Science, Technology, and the Metaphysics of Science," "Work, Technology, and Social Control," and "The Technocratic Utopia and Western Rationality." The course analyzes the nature of knowledge and the processes by which knowledge is derived in science and technology. The student is expected to gain insights into the methodologies of science and technology and

the impact of science and technology upon society. Prerequisite for enrollment is the course in sociology, *The Sociological Perspective*.

Other courses identified: *Introduction to Computing (Interdisciplinary)*. In this course, the computer is viewed as a "defining technology" and in addition to dealing with the computer as a particular artifact, the instructor directs discussion to the social implications of widespread computer use. *Drugs and Society* introduces students to experimental protocols, uses computer-assisted simulations, explores the societal implications and the ethical and legal issues surrounding the use of drugs. *Psychology in Industrial Organizations* confronts the way in which technological developments impact upon behavior in the workplace, calling upon students to develop solutions to problems occasioned by introduction of technology. *The Politics of Science* examines the relationship between politics and science and considers a "philosophy of technology." *Chemistry in Our World* is identified as a course in which "the principles of chemistry are applied to the study of technological society," and it moves from study of basic principles of chemistry to a consideration of other topics, including energy for the future, population and food, and water use and misuse. The chemistry department, in addition to this course and the course on drugs, is planning to develop a third technology-oriented offering, *Energy and Our Environment*. The *History of American Medicine* explores the way in which medical knowledge and the practice of medicine have interacted with social and political forces in the United States through consideration of three major topics: medicine and class, medicine and race, medicine and gender. An interdisciplinary course, *The Nuclear Age*, developed by a three-person team representing art, history, biology and mathematics, has been approved for a trial run by the college academic policy committee.

These courses all grew out of the interest and concern of an individual faculty member, a department (the three chemistry courses) or a team of persons with common interest. Kenyon did not announce a particular intent to explore the relation of technology and education; individuals developed the courses because they determined within their respective disciplinary positions that the time called for a course that went beyond the traditional exploration of the discipline itself. It should also be noted that the academic administration has recognized and supported the development. Additionally, the provost has recently organized discussions to deal with matters of general educational concern, including the place of technology. In short, the environment was conducive to exploration in an institution strongly committed to the traditional liberal arts.

It is worthy of further note that until representatives from the Council of Independent Colleges met with faculty involved in these courses there was but limited awareness of how other persons were engaged in similar efforts. The academic administration, aware of the developing interest in the relation of technology and liberal education, is facilitating further conversation among the faculty who have embarked on these new curricular

developments. In the final analysis, however, the strength of the Kenyon approach will be in the individual initiatives taken out of conviction that the respective disciplines not only had resources to deal with broad technology-liberal education issues but also had a responsibility to foster the dialogue.

COMMON THEMES

Although the programs in technology and the liberal arts reflect the particular culture of each campus, several common themes are apparent in each effort.

Faculty-Student Matching

The history of educational change suggests that it begins with the efforts of individual faculty members. Successful courses are those which are matched to the experience and interest of the teachers. This is true for the course in *Humanities and the Environment* at Wartburg and the biomedical technology courses at the College of St. Catherine. This thesis is even more evident with discipline-based courses at Kenyon. The latter proves that there exists a great range of technology, so that examples can be chosen to match the backgrounds of the faculty. To try to adopt courses from other colleges or to choose whichever faculty member is available does not appear to work.

One major problem in incorporating the study of technology into the curriculum is the need for teaching materials. However, this did not seem to hinder the development of courses. What faculty appear to need most in order to develop new courses is: 1) perspective on current issues, 2) broad preparation, 3) a chance to learn from those who have been successful, 4) a start on resource materials, and 5) encouragement and support.

In addition, a new course needs to be matched to the background of the students. A constant concern facing faculty members was how much science and mathematics to include in the course. The student desire to steer away from those subjects can be overcome when the topics are perceived to be relevant and emphasize the usefulness of the technology.

The challenge we face as educators is to develop new courses (or segments of courses) which will give students depth of understanding in an area of technology, confidence that they can indeed learn technology, and recognition of the pleasure available from that learning (Truxal, p. 5).

Relationships Among the Parts

The success of the courses in technology relied as much upon the relationship of the administration and the institution to the project as upon

the individual faculty member. In all three case studies it was evident that the colleges were able to take advantage of the contributions of innovative and imaginative faculty members. A comment that constantly surfaced was "Our dean is supportive." A concrete set of incentives—both material and moral—were created to prompt teaching faculty to develop courses in technology.

The development of successful programs requires a steady, long-term commitment by the faculty and the administration. Many of the successful courses have been taught in one form or another for five or ten years. Each of the colleges we studied had structures that encouraged innovation: interdisciplinary courses that were problem-centered, capstone courses that focused on the ethical issues of a major field or student-outcome-based courses. The administrations in these institutions also had the ability to make the place of technology in the liberal arts an agenda item for faculty debate.

There was also a relationship between the involvement in teaching technology and each institution's unique setting. The focus on biomedical technology in a high tech area, on agriculture in a rural area, on a concern to make the liberal arts relevant in a strong traditional liberal arts institution, all added to the strengths of the programs. The emphasis on the religious/ethical issues also provides a framework within which to consider the uses of technology. In these value-centered institutions, it is appropriate that the concern is on the uses to which technology is put.

Multi-disciplinary Dimension

The courses and programs in technology again reveal the problems of developing effective multi-disciplinary courses. Many of the courses that sought to relate technology and the liberal arts were one dimensional, either emphasizing science or the social and human implications of the technology.

The more successful courses that dealt with science and social process had a tendency to be taught by the natural scientists. This may be due to the way we perceive technology, as a blending of science and technology. However, social and behavioral science faculty members as well as humanities faculty members can approach technology through their own background, for science and technology are people-related topics. People can become technologically literate through many appropriate disciplines. However, it is important to emphasize the unique contribution that the traditional liberal arts program brings to the task—the ability to evaluate, to debate the uses of technology and to chart its future.

TECHNOLOGY'S UNIQUE ROLE IN THE NEW LIBERAL LEARNING

Technology is not only a process of designing and creating, but also a way of knowing. The methodology associated with technology differs substantially from the methodology in the humanities and the sciences.

Unlike basic science, technology is action-oriented: it places a premium on intervention. Technology deals with uncertainty and ambiguity; it focuses on decision-making, on defining what needs to be done, on finding a solution. This method of inquiry must be an important component in the education of today's student because it is the dominant mode of inquiry for decision-making in our time.

This fact alone should justify the appearance of the study of technology as part of the basic curriculum of liberal education. In addition, however, technological integration also leads to quite interesting by-products. Issues that have remained unresolved in the traditional liberal arts college often find new solutions. As stated before, one such issue has been the inability to effectively introduce multi-disciplinary studies. The study of technology presents a way to bridge the study of science and the humanities. Technology, in a unique way, interrelates scientific and human purposes. Technology inevitably carries with it questions of ethics; technological change has political, social, psychological and economic implications. Technology, as a bridge between "two cultures," demands a trans-disciplinary approach.

The introduction of the study of technology also may bring a new sense of dignity to dealing with the "how-to" approach in education. Liberal education has focused on the "why," dealing with the discovery and understanding of knowledge, but not its application. Technology springs from the arts and crafts, yet uses its understanding of science to serve human needs. It uses the technologists' "how to" as a bridge between the scientists' question of "what is" and the humanists' "what ought to be."

Introducing the study of technology into the liberal arts curriculum will also help prepare students for a career. The liberal arts college has traditionally tried to provide its students with basic knowledge as opposed to training for specific careers. The expanding presence of technology in the workplace introduces a new array of basic skills, including quantitative reasoning, decision-making theory and the understanding of how systems work. There is a need to develop skills that are "generalizable, highly flexible and enduring" (Iozzi, p. 552). These types of skills will be the critical ones as traditional career paths erode and new paths evolve.

The development of technology has also developed new types of professionals, non-traditional careers in which technology is a critical component. "The new professionals will be individuals who will have to deal with the complex interface problems at the boundaries where technology and society interact with each other" (Friedman, p. 202).

As educators grope for academic change responsive to a technological society, we can expect many educational experiments in the years ahead. The "new liberal learning" will come about when education in technology, with its distinct body of knowledge and method of inquiry, is fully incorporated into the liberal arts curriculum. Without this new dimension students will be ill-equipped to deal responsibly with the world in which they live and with the major issues of the day.

REFERENCES

Friedman, Edward A. "Technology and Higher Education in America for the Next Decade," *Liberal Education*, 65, 198–205.

Iozzi, Louis A. "Education for the 80's—And Beyond: The Socio-Scientific Reasoning Models," *Needs of Elementary and Secondary Education in the 1980s: A Compendium of Policy Papers*, Washington, D.C., January 1980, 549–567.

Kranzberg, Melvin. "The Wedding of Sciences and Technology: A Very Modern Marriage," Paper prepared for a New Liberal Arts Symposium, January 19–20, 1984, Davidson College, North Carolina, 27–36.

Truxal, John G. "Technology in Liberal Education," Paper prepared for Sloan Foundation Conference, April 1984.

Truxal, John G. "Thoughts on Teaching Technology," *The Forum for Liberal Education*, American Association of Colleges (AAC), May 1, 1985, pp. 2–4.

CHAPTER 3

BIBLIOGRAPHIC RESOURCES: BOOKS, JOURNAL ARTICLES, SYLLABI READINGS

Sharon D. Sweet

The following bibliography represents the culmination of a year's effort, during which the author read extensively in the area of technology and the liberal arts. For every one title appearing on this list, nine or ten were excluded. Inclusion of a specific title was based on its value acknowledged by the literature of the field and on personal opinion of the author. The first section reviews books, and the second covers journal articles. A third section is devoted to syllabi readings.

Introduction: Recommended Books

Among the books we reviewed, approximately a dozen titles seemed especially useful and of broad, general interest, and have been marked with three asterisks (***); some twenty titles are marked with two asterisks (**), being of more specific value.

Subject categories are broad, but offered with the intent to inform the reader of the general nature of the reading. The brief annotations are included to serve the same purpose.

The classifications may appear to be somewhat arbitrary (or even inappropriate) to the informed reader; the author takes full responsibility for the decisions and acknowledges that many titles possess a certain amount of ambiguity. Titles were organized according to what appeared would be the most informing for the reader.

The following titles should be noted as being of special worth:

Bolter's *Turing's Man* (p. 31) is suggested reading for entering freshmen at several colleges. The style is easy to read and comprehend. The book provides an excellent understanding of what computers *are* and *are not*.

Mind Storms, by Seymour Papert (p. 32), provides an important insight into his MIT research with children, and suggests that the high interaction between computers and children can, indeed, improve thinking styles and reasoning abilities.

Samuel Florman's writings (p. 32), both in this list and in the journals, are always worthwhile. As an engineer, his comments about liberal arts studies are to be noted.

One should be familiar with Toffler's works (p. 33–34) (*Future Shock, The Third Wave*). As a futurist, he stimulates thought about how we choose to shape our future. His 1970 piece illustrates his ability to accurately

forecast, as many aspects of our present society reveal. His work is thorough, well written and carefully documented.

The category of science fiction (p. 36) is included here as in all three lists, primarily for its ability to inform the reader, encourage "futures" kind of thinking, and its general ability to make the "foreign/alien" less threatening. Asimov's introduction to *Machines That Think?*, which discusses artificial intelligence, should be noted.

Sherry Turkle (p. 36) came to M.I.T. with no prior experience with information technology. As a sociologist, she brings new insight to Papert's work, specifically, and generally explores the human interaction with information technology.

On pages 37-38, two authors and their work should be noted: David Hawkridge's piece about the "future" of education, and Emmanuel Mesthene's extremely valuable understanding of "technological change."

Through a parallel method of "fiction" and "fact" writing, Gerard O'Neill (p. 38) explores space colonization. A well-regarded physicist and researcher in space colonization, he notes that we have the technology and knowledge now to accomplish such a mission.

Machina Ex Dea (Joan Rothschild, p. 39) competently explores the special tensions that exist between women and technology and presents a more in-depth examination of the subject than her article, noted in the journals list.

The "Well-Read" Bibliography

(or what books the "well-read" person should read in technology/liberal arts)

Artificial Intelligence

Boden, Margaret A. *Artificial Intelligence and Natural Man* (New York: Basic Books, Inc., Publishers, 1977).

Thorough discussion of what artificial intelligence is and can be; discussion of the personal dimension, language and understanding, the visual world, new thoughts from old, relevance of artificial intelligence.

McCorduk, Pamela. *Machines Who Think* (San Francisco: W.H. Freeman and Company, 1979).

Discusses previous and present work done in the field of AI; presents material regarding future possibilities, notes the moral issues and ramifications.

Change

* Drucker, Peter F. *The Age of Discontinuity: Guidelines to Our Changing Society* (New York: Harper & Row, 1969).

Discusses the changed position and power of knowledge, the impacts of knowledge and the impacts *on* knowledge of work, performance and individual responsibility.

Computer Literacy

Lombardi, John V. *Computer Literacy* (Bloomington, Ind.: Indiana University Press, 1983).

Good introduction for someone about to purchase a home computer system; easy to read and comprehend; not without humor—he defines a "big system" as anything larger than what one presently owns.

Deken, Joseph. *The Electronic Cottage* (New York: William Morrow and Company, Inc., 1982).

Addresses concept of computer literacy; suggests that the education/learning process will change markedly.

Computers

*** Bolter, J. David, *Turing's Man: Western Culture in the Computer Age* (Chapel Hill, N.C.: The University of North Carolina Press, 1984).

Excellent history of computing and A.M. Turing's work; presents projections of technology in the near future.

** Dertouzos, Michael L., and Joel Moses (eds.), *The Computer Age: A Twenty-Year View* (Cambridge, Mass.: The MIT Press, 1979).

Writings explore following categories: individual prospects, socioeconomic effects/expectations, and trends in traditional computer uses and the underlying technologies. Includes the "classic" Daniel Bell and Joseph Weizenbaum debate.

** Frude, Neil, *The Intimate Machine* (New York: The New American Library, 1983).

Discusses the "computer-as-companion" in various settings; examines ethics, values of "soft technology"; considers role of education in the future.

Mathew, Walter M. (ed.), *Monster or Messiah? The Computer's Impact on Society* (Jackson, Miss.: University of Mississippi, 1980).

Writings examine the computer in the following settings: historical context, society, people, its usage, and values in the computer age.

Pask, Gordon, and Susan Curran, *Micro Man* (New York: Macmillan Publishing Co. Inc., 1982).

Authors suggest that deep qualitative changes are taking place in the relationship between machines and human beings, perhaps due to the evolution of a new species. . . micro-man; "an information environment that is based upon a revolutionary expansion of mind, be it individual, social, or wrought in 'material-other-than-brain-stuff.' "

Education

Christopher, K., *Evaluating Instructional Technology* (New York: John Wiley and Sons, 1980).

The thrust of the writing is toward "evaluation," yet offers some valuable insight into computer technology as the "fourth revolution" in education. (The first—development of the school; second—emphasis on writing as opposed to speech; third—invention of the printing press.)

Laver, Murray, *Computers and Social Change* (Cambridge: Cambridge University Press, 1980).

Discusses the increasing need for on-going education/lifelong learning; notes that "sabbaticals may cease to be an academic privilege, and become the norm"; social issues are addressed. (The text of this book was written on a word processor, only chapter headings, etc. are typeset.)

*** Papert, Seymour, *Mindstorms: Computers, Children, and Powerful Ideas* (New York: Basic Books, 1980).

Describes research carried out at M.I.T., using LOGO and the cybernetic Turtle; shows the use of computers to improve thinking styles and reasoning abilities.

Engineering

Florman, Samuel C. *Engineering and the Liberal Arts: A Technologist's Guide to History, Literature, Philosophy, Art, and Music* (New York: McGraw-Hill, 1968).

What one engineer believes all engineers should know about the liberal arts, very detailed and specific.

*** Florman, Samuel C. *The Existential Pleasures of Engineering* (New York: St. Martin's Press, 1976).

A widely quoted book by an extremely articulate engineer; excellent argument from the "engineering" side.

National Academy of Sciences, National Academy of Engineering, Institute of Medicine, *The National Research Council: Current Issues and Studies* (Washington, D.C.: National Academy of Sciences, 1979).

Looks at the engineer's role in/with technology, refers to U.S. Federal District Judge David Bazelon's legal opinions regarding technology policy and practice.

Ethics

Johnson, Douglas W. *Computer Ethics: A Guide for the New Age* (Elgin, Ill.: Brethren Press, 1984).

Thoughtful examination of the issues—individual integrity, privacy of information, expanded copyright law to protect products; basic ethics—people make decisions while computers process data.

Futuristics

Botkin, James W., Mahdi Elmandjra, and Mircea Malitza, *No Limits to Learning: Bridging the Human Gap* (Oxford: Pergamon Press, 1979).

This report to the Club of Rome discusses the "world problematique," e.g., progress has become so hectic and haphazard that people are increasingly at odds with the real world.

Cornish, Edward, with members and staff of the World Future Society, *The Study of the Future* (Washington: World Future Society, 1977).

One of many futuristic societies that tries to anticipate the future and plan for alternative forms of social life; special attention paid to education.

Ferkiss, Victor C. *50. FUTUROLOGY: Promise, Performance, Prospects*, The Center for Strategic and International Studies, Georgetown University, Washington (Beverly Hills: Sage Publications 1977).

Examines value relevance within the social sciences and in education, where futurology is increasingly used as a heuristic device.

Fuller, R. Buckminster, *Operating Manual for Spaceship Earth* (New York: Simon and Schuster, 1969).

Argues that humans have come to near extinction as "specialists," that the ramifications of technology will enable us to become more generalist and comprehensive in our approach to knowledge; argues on the side of general/liberal education, as opposed to professionalism.

Kahn, Herman, William Brown, Leon Martel, with the assistance of the staff of the Hudson Institute, *The Next 200 Years* (New York: William Morrow and Company, Inc., 1976).

A "futuristics" examination of the next years, with attention paid to technology, society, occupations, etc.

Shane, Harold G., and M. Bernadine Tabler, *Educating for a New Millenium: Views of 132 International Scholars* (Bloomington, Ind.: Phi Delta Kappa Education Foundation, 1981).

Stimulating material regarding the future needs and direction of education; worthwhile and rather concrete suggestions offered.

Stine, G. Harry, *The Hopeful Future* (New York: Macmillan, 1983).

The author sees technology as offering an unparalleled opportunity to shape the world and outer space for human benefit; suggests an ecological approach through a systems-engineering point of view.

*** Toffler, Alvin, *Future Shock* (New York: Random House, Inc., 1970).

Scholarly writing, well researched and documented, and though written for a broad audience, it is well worth reading, 15 years later.

*** Toffler, Alvin, *Previews and Premises* (New York: William Morrow, 1983).

Examines the problems of today and discusses the kinds of transformation necessary to bridge the future; cites the need for education to make "accommodative changes" to accelerate the cultural lag between systems in our society.

Toffler, Alvin, *The Third Wave* (New York: William Morrow and Company, 1979).

Extension of *Future Shock* and particularly emphasizes communication technology. He advocates that the world industrial society, including both capitalist and socialist nations, is in a "general crisis."

** Toffler, Alvin (ed.), *The Futurists* (New York: Random House, Inc., 1972).

Noted authors discuss "whether we should be conscious of what we are doing and through that consciousness, try to do it better." Material by the following authors should be noted: Margaret Mead, Marshall McLuhan, Arthur C. Clarke, Kenneth E. Boulding, Daniel Bell, Bertrand de Jouvenel, and R. Buckminster Fuller.

Humanities/Computers

** Hockey, Susan, *A Guide to Computer Applications in the Humanities* (Baltimore: The Johns Hopkins University Press, 1980).

Her inclusion of actual printouts for programs is especially worthwhile, as is the address list for organizations that can provide further assistance. Considered to be one of the best resources of its type.

Liberal Arts

Feinberg, Walter, *Understanding Education* (Cambridge: Cambridge University Press, 1983).

Examines liberal education and professionalism in the light of the effects of the new technology; reconceives and restructures the domain of educational inquiry.

Literacy

** Scribner, Sylvia, and Michael Cole, *The Psychology of Literacy* (Cambridge, Mass.: Harvard University Press, 1981)

Examines the influence of literacy on the process of formal operational thought through their research with the people of Vai, in Liberia.

Mass Communications

** Greenfield, Patricia Mark, *Mind and Media* (Cambridge, Mass.: Harvard University Press, 1984).

Offers valuable insights into the effects of communication modes upon the way in which one thinks; following McLuhan, she notes the tendency of communication technologies to shape thinking through their form.

Philosophy

** Ellul, Jacques, *The Technological Society* (New York: Vintage Press, 1964).

Though written over 20 years ago, this book is worthy of attention. Frequently referenced in the literature, it takes more of a "technophobe" view.

Jantsch, Erich, *The Self-Organizing Universe—Scientific and Human Implications of the Emerging Paradigm of Evolution* (Elmsford, N.Y.; Pergamon Press, 1980).

Author presents a concept of metafluctations—wherein change and necessity are complementary processes, suggests looking at models of life, not mechanical models.

*** Kuhn, Thomas S., *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1970).

Author's discussions about scientific revolutions illuminate the scientific mode of inquiry. "Deduction" and "induction" are defined in their concepts and utilization in creating theories.

Sloman, Aaron [Reader in Philosophy and Artificial Intelligence, Cognitive Studies Programme, University of Sussex.] *The Computer Revolution in Philosophy: Philosophy, Science, and Models of Mind* (Atlantic Highlands, N.J.: 1978).

Author suggests that a revolution in philosophy is connected to revolution in the scientific study of people and the relevant applications of technology. Uses the metaphor of "computer as toy."

Tullock, Gordon, *The Organization of Inquiry* (Durham, N.C.: Duke University Press, 1966).

Focuses upon the scientific mode of inquiry; the scientific process has two motives—"one is to understand the natural world, the other is to control it"; examines the concept of "induction" and its relationship with "discovery."

Psychology

** Gardner, Howard, *Frames of Mind: The Theory of Multiple Intelligences* (New York: Basic Books Inc., Publishers, 1983).

Gardner addresses the different modes of thinking that individuals hold, within the context of engineering, technology, literacy, informed citizenry and computers.

Science

** Committee on the Federal Role in College Science Education of Non-Specialists, *Science for Non-Specialists: The College Years* (Washington: National Academy Press, 1982).

Though infrequently referenced and generally neglected, it is a highly viable report.

Science Fiction

*** Asimov, Isaac, Patricia S. Warrick, and Martin H. Greenberg, *Machines That Think?* (New York: Holt, Rinehart, and Winston, 1983).

Anthology of short stories about artificial intelligence and robots. Especially worth reading is Asimov's introduction, in which he discusses the fears of the "technophobe"; he sees the brain (human) and mind (machine) existing symbiotically.

Social Sciences

Barnes, Barry, *T. S. Kuhn and Social Science* (New York: Columbia University Press, 1982).

The author uses Kuhn's account of scientific research and the growth of knowledge as a way of examining social science research. It is most helpful in elucidating Kuhn's thoughts.

Sociology

** Turkle, Sherry, *The Second Self: Computers and the Human Spirit* (New York: Simon and Schuster, 1984.

Examines the present culture of communications technology and its participants and questions what we will become in the future. Excellent sociological and psychological evaluation.

Technological Literacy

Yff, Joost, and Michael J. Butler, *Technological Literacy: Challenge for Teacher Education* (Washington: ERIC Clearinghouse on Teacher Education, 1983, #SP 021 725).

Good overall treatment of the subject.

Technology

** Bellow, Saul, Daniel Bell, Edmundo O'Gorman, Sir Peter Medawar, Arthur Clarke and Foreward by Daniel J. Boorstin, *Technology and the Frontiers of Knowledge*, (Garden City, N.Y.: Doubleday & Company, Inc., 1973).

Though an older collection of writings, an excellent source for a philosophical concept through the words of authors who were on the cutting edge of that decade.

Berman, Morris, *The Reenchantment of the World* (Ithaca, N.Y.: Cornell University Press, 1981).

Berman notes that since we cannot return to alchemy or animism, we must pursue and find some type of "holistic, or participating, consciousness and a corresponding sociopolitical formation."

Clarke, Arthur C., *Profiles of the Future*, 4th Edition (New York: Harper & Row, Publishers, 1973).

Widely renown for science fiction writing, the author outlines what ultimate goals technology may achieve, based on current facts.

Davidson, Frank P., with John Stuart Cox, *Macro: A Clear Vision of How Science and Technology Will Shape Our Future* (New York: William Morrow and Company, Inc., 1983).

This book is an outcome of a series of seminars on macro-engineering conducted at M.I.T. from 1970 on.

de Ferranti, Basil (ed.), *Living with the Computer* (London: Oxford University Press, 1971).

Another British work examining the relationship between computers and education.

** Evans, Christopher, *The Micro Millenium* (New York: The Viking Press, 1979).

Basic premise is the comparison between the Industrial Revolution and the Computer Revolution; suggests technology can amplify the individual's brain power.

** Feibleman, James K., *Technology and Reality* (The Hague: Martinus Nijhoff Publishers, 1982).

The impact on philosophy of technology and science; one of the author's purposes is to remind the ontologist of his debt to the artificer.

Florman, Samuel C., *Blaming Technology: The Irrational Search for Scapegoats* (New York: St. Martin's Press, 1981).

Florman protests the comparing of today's technology with communism in the 1950s and witchcraft in the 1690s. Technology . . . "a word so steeped in emotional implication that its very mention drowns out the voice of reason."

*** Hawkridge, David, *New Information Technology in Education* (Baltimore: The Johns Hopkins University Press, 1983).

This British author gives a remarkable sense of what learning may become; to stretch the mind, this may be the *one* book to read.

** Kidder, Tracy, *Soul of a New Machine* (Boston: Little, Brown, 1981).

Gives good insight into the personalities and motivations of the individuals who built a "new machine."

** Krueger, Myron W., *Artificial Realities* (Reading, Mass.: Addison-Wesley, 1983).

Author states: "An artist who is alienated from technology cannot speak for a technological culture, any more than a technologist who disdains aesthetics can design a humane technology."

** Macdonald, Stuart, D.McL. Lamberton, Thomas Mandeville (eds.), *The Trouble with Technology: Explorations in the Process of Technological Change*, (London: Frances Pinter Publishers, 1983).

Of particular value are the chapters by Kenneth Boulding and Stuart MacDonald, in their discussion of technology's impact on society and what technology is.

*** Mesthene, Emmanuel G., *Technological Change: Its Impact on Man and Society* (Cambridge, Mass.: Harvard University Press, 1970).

Although this book was written some 15 years ago, it remains a valuable, informative reference.

** Moser, Leo J., *The Technology Trap: Survival in a Man-Made Environment* (Chicago: Nelson-Hall Inc., Publisher, 1979).

The author analyzes the reason why modern technology seems to threaten our minds and personalities and the relationship between mind and environment.

Norman, Donald A., *Learning and Memory* (San Francisco: W.H. Freeman and Company, 1982).

An examination of human learning and memory, viewed through cognition, learning and memory, and artificial intelligence; author suggests that it is time for a new discipline . . . "cognitive engineering," in order to best utilize communication technology and the unique qualities of the human mind.

*** O'Neill, Gerard K., *2081: A Hopeful View of the Human Future* (New York: Simon and Schuster, 1981).

Physicist at Princeton, directs research (supported by NASA and the Space Studies Institute) in space physics and applications. He calls for a generation that is literate in both literary/artistic and scientific cultures.

Pacey, Arnold, *The Culture of Technology* (Cambridge, Mass.: The M.I.T. Press, 1983).

British author who questions whether technology can be culturally neutral; explores the "definition" of technology; examines world issues.

Ramo, Simon [Director, TRW Inc.; Chairman of the Board of Directors, the TRW-Fujitsu Company], *America's Technology Slip* (New York: John Wiley and Sons, 1980).

The author speaks to the current experience of malaise, dislocation, and frustration of an immense, almost uncontrollable imbalance between rapidly accelerating technological advance and lagging social progress.

Ramo, Simon, *What's Wrong with our Technological Society—and How to Fix It* (New York: McGraw-Hill Book Co., 1983).

Suggests the use of social and political advance and innovation as the means of exiting from the nuclear weapons race; states that the power of information technology will enable us to avert chaos.

Reinecke, Ian, *Electronic Illusions: A Skeptic's View of Our High-Tech Future* (Harrisonburg, Va.: R.R. Donnelley & Sons Company, 1984).

As a self-acclaimed techno-skeptic, the author addresses this book to his fellow doubters and nonbelievers, to give the other point of view.

Starr, Chauncey, and Phillip C. Ritterbus (eds.), *Science, Technology and the Human Prospect*, Proceedings of the Edison Centennial Symposium (Elmsford, N.Y.: Pergamon Press, 1980).

Chapters focus on "growth to limits" concept of technology and society.

** Winner, Langdon, *Autonomous Technology: Technics-Out-Of-Control as a Theme in Political Thought* (Cambridge, Mass.: The M.I.T. Press, 1977).

Closely examines the definition of technology in all its ramifications; questions whether "technology" has, indeed, become autonomous.

Ziegler, Donald J., James H. Johnson, and Stanley D. Brunn, *Technological Hazards* (State College, Pa.: Commercial Printing, Inc., 1983).

Offers a good diagrammed model for risk assessment.

Technology/Philosophy

*** Mitcham, Carl, and Robert Mackey (eds.), *Philosophy and Technology: Readings in the Philosophical Problems of Technology* (New York: The Free Press, 1983).

Considered by many to be *the* collection of readings.

Technology Policy

Haberer, Joseph (ed.), *Science and Technology Policy* (Lexington, Mass.: D.C. Heath and Company, 1977).

A collection of pieces which examine the ethical and social implications of policy and the resulting decisions.

Women's Studies

*** Rothschild, Joan, *Machina Ex Dea* (Elmsford, N.Y.: Pergamon Press, 1983).

A feminist analysis of technology-culture tensions, including technology/housework/women's liberation, etc.

** Zimmerman, Jan (ed.), *The Technological Woman: Interfacing with Tomorrow* (New York: Praeger Publishers, 1983).

Feminist view of women's place in the world of information technology.

Introduction to Journal Articles

With a few exceptions, the following journals have been researched back to 1979, with the most recent review being undertaken in June of 1985. Those

articles published prior to 1979 are included because of their particular value to the subject of technology and the liberal arts.

The categories follow roughly the same rationale as those in the previous bibliography, with the following exceptions: the broader topics of computer literacy and computers have been more refined and "new" topics appear, denoted as "information literacy," "technological literacy," and "technology." The following articles are of special interest.

Cleveland (p. 43) refers to the legendary Danish king, Canute, who stood on the beach and commanded the tides to stand still as proof of his power and then compares Canute with the "leaky-ness" of information (the more it's shared, the more there is). He offers two interesting facts: Xerox machines are licensed by the government in the USSR; and in Bulgaria, use of typewriters is restricted. He concludes by stating that the modern King Canutes will be wise to assume that the information tide is coming in and adapt their behavior accordingly.

Pritchard and Shane (see pages 43–44) offer their views of education and technology in the future, through the medium of humor, with Shane looking at "edperfection in a unihumanized" world community.

Robert Good's "Almost Valedictory" (p. 44) is a strong statement of his own guiding philosophy for the liberal arts. Its poignant effect is underscored by his death from cancer last fall, a significant loss to the academic community.

Levinson (p. 44) sees technology as being a means to safely experience our world (and solar system, etc.), as a proxy, if you will, for perception in the attainment of knowledge, an extension of human perception.

Another "quality" piece from Samuel Florman (p. 45), examining Pope's often misquoted line ". . . a little **knowledge** [emphasis added] is a dangerous thing." The correct quote ". . . a little **learning** [emphasis added] is a dangerous thing," has relevance for a technologically informed public.

Guenther (p. 46) urges us to be very clear about what it is we need to remember and what we can yield to other froms of "memory banks." Asimov is quoted as saying that "Our troubles stem not from the fact that we've forgotten, but that we remember too well; we don't forget enough." He suggests that penmanship, spelling and arithmetic are specific targets for potential "forgetting."

Christopher Freeman (p. 48) identifies specific factors that define a technological revolution; establishes the parameters of a revolution in technology in terms of social impact.

Paltiel, Rothschild, and Zimmerman (page 50) examine the issues surrounding women and technology, noting past, present and future contributions that women have made.

Technology/Liberal Arts Journal Articles

Artificial Intelligence

Johnson, George. "Thinking About Thinking," *APF Reporter*, Winter 1985, pp. 3-6.

The view from the field of mass communications; notes interest in AI by industrialists and venture capitalists.

Lehman-Wilzig, Sam N. "Frankenstein Unbound: Towards a Legal Definition of Artificial Intelligence," *Futures*, December 1981, pp 442–457.

Analyzes the existing jurisprudential principles upon which cybernetic law of the future may be based.

Von Laue, Theodore H. "Technology, Society, and Freedom in the Tower of Babel," *Technology in Society*, 1983, Vol. 5, pp. 119–138.

Proposes need for "all-inclusive, harmonizing civic artifacts, visible and invisible, and the will to pioneer them."

Citizen/Public Participation

Brooks, Harvey. "The Resolution of Technically Intensive Public Policy Disputes," *Science, Technology, & Human Values*, Winter 1984, Vol. 9, #1, pp. 39–50.

Discusses what to do when the experts disagree; use of informed citizens in policy decisions.

Harrison, Anna J. "Commentary," *Science, Technology, & Human Values*, Winter 1984, Vol. 9, #1 pp. 123–125.

Suggests that it is the lack of understanding of the nature of scientific knowledge, especially the uncertainties, that causes problems in the use of scientific knowledge.

Nelkin, Dorothy, and Michael Pollak. "Public Participation in Technological Decisions: Reality or Grand Illusion? *Technology Review*, August/September 1979, pp. 55–65.

Considers that consensus is probably not possible in volatile issues; suggests a formula that "gives due weight to social and political factors, appropriate involvement of affected interests; unbiased management; fair distribution of expertise, and a real margin of choice."

Olsen, Darryll, and William R. Freudenburg. "The Public Interest and Technology Assessment: Two Dozen Eternal Truths About People and Technology Revisited," *Technological Forecasting and Social Change*, 24, 1984, pp. 93–95.

A supplement to J.B. Sullivan's 1983 list, from the quasi-scientific perspective of public involvement facilitators.

Wenk, Edward, Jr. "Civic Competence to Manage Technology," *Technological Forecasting and Social Change*, Vol. 26, #2, September 1984, pp. 127–134.

Examines technology in the role of a social amplifier; speaks of the "route for *noblesse oblige* of the technically literate, who are also citizens."

Winner, Langdon. "Do Artifacts Have Politics?" *Daedalus*, Winter 1980, pp. 121–136.

Addresses need for the understanding of which technologies and which contexts are important to humanity.

Wynne, Brian. "Redefining the Issues of Risk and Public Acceptance: The Social Viability of Technology," *Futures*, February 1983, pp. 13–32.

Suggests that the concept of risk assessment be "enlarged in line with the real substance of social issues of technology policy."

Engineering

Florman, Samuel C. "Existential Pleasures of Engineering: 15 Years Later," *Technology Review*, April 1984, pp. 6–7.

Update of author's previous publication and his view of engineering.

Florman, Samuel C. "Will Women Engineers Make a Difference?" *Technology Review*, Nov/Dec 1984, pp. 51–52.

Addresses the special qualities American women are bringing to the practice of engineering.

Hornig, Lilli S. "Women in Science and Engineering: Why So Few?" *Technology Review*, Nov/Dec 1984, pp. 31–41.

Explores the social costs of women's under-utilization in these fields.

Futuristics

Buchen, Irving H. "The Future of 1984," *Technology in Society*, Vol. 6, 1984, pp. 241–248.

Examines Orwell and other writings for the relevance of their message for the future.

Roddenberry, Gene. "Mr. Spock and Gaan: Alien Perspectives on the Future," *The Futurist*, February 1985, pp. 39–41.

The creator of Mr. Spock and other aliens uses conversations with Spock for glimpses of the future.

Van Gelder, Lindsy. "How to Preserve Our Souls in a Microchip World," *Ms.* July 1985, pp. 62–64.

Examines the future through the thinking of Sherry Turkle (author of *The Second Self*).

Information Literacy

Barger, Robert Newton. "Computer Literacy: Toward a Clearer Definition," *T.H.E. Journal*, October 1983, pp. 108–112.

Provides one of the better "definitions" of computer literacy.

Cleveland, Harlan. "King Canute and the Information Resource," *Technology Review*, January 1984, pp. 12-13.

Stresses need for transnational information flows.

Diebold, John. "Future View: New Challenges for the Information Age," *The Futurist*, June 1985, p. 68.

Examines the immediate future of information technology; emphasizes need for computer resources to assure greater quality in service than presently accepted.

Hade, Daniel D. "Literacy in an Information Society," *Educational Technology*, August 1982, pp. 7-12.

A view of literacy through library science; notes hierarchical process of information; dimensionality of literacy.

Haibo, Liu. "Man and Machine—An Interactive and Interadaptive System," *Impact of Science on Society*, #2, 1983, pp. 171-178.

Examines the history of machines and the human relationship to and with them (author is research associate and vice-director of Shenyang Institute of Automation, People's Republic of China).

Knauer, Gene. "Future View: The Need for 'Knowledge Processing'," *The Futurist*, April 1985, p. 76.

Defines "data" and "information"; notes need for "making sense of this technology."

McMeen, George R. "Developing Computer Literacy Workshops for College Faculty," *Educational Technology*, April 1984, pp. 25-29.

Offers assistance with workshop implementation.

Norton, Priscilla. "An Agenda for Technology and Education: Eight Imperatives," *Educational Technology*, January 1985, pp. 15-20.

Strategies to prepare "individuals to benefit from the accessibility of information."

Peelle, Howard A. "Computer Metaphors: Approaches to Computer Literacy for Educators," *Computing Education*, Vol. 7, #2, 1983, pp. 91-99.

Notes that the meaning of literacy is complex, contextual and culturally based; uses metaphors of computer—as person, tool, brain, map, glass box, vitamin, palette, mentor and catalyst.

Pritchard, William H., Jr. "Instructional Computing in 2001: A Scenario," *Phi Delta Kappan*, January 1982, pp. 322-325.

A humorous look at 2001.

Ringle, Martin. "Computer Literacy: New Directions and New Aspects," *Computers and People*, November/December 1981, pp. 12–15.

Comments and observations based on author's experiences teaching a computer literacy course for liberal arts students at Vassar.

Shane, Harold G. "Two Centuries After: Schooling and Social Change in an Orwellian Futureworld," *Phi Delta Kappan*, January 1984, pp. 337–341.

"A prescient look at 'edperfection' in an 'unhumanized' world community"; expresses concern about the glut of data and information and turning it into knowledge.

Winner, Langdon. "Mythinformation in the High-Tech Era," *Bulletin of Science, Technology, and Society*, Vol. 4, #6, 1984, pp. 582–596.

Explores the theme that "without guiding wisdom, even the best tool can be misused."

Philosophy

Good, Robert C., "A Time for Summing Up—'My Almost Valedictory' " *Change*, October 1984, pp. 5–9.

A speech that embodies the valuable philosophy of a liberal arts college president. A forceful reminder of what the "liberating arts" are all about.

Levinson, Paul. "Information Technologies as Vehicles of Evolution," *Technology in Society*, Vol. 6, 1984, pp. 193–206.

Examines four kinds of information technology: perception extenders; cognitive processing enhancers; disseminators of information via high levels of abstraction; and disseminators of information via high levels of realism; examined through the "philosophy" of media.

Science Fiction

Lerner, Fred. "Forum: Science Fiction Versus Science Fact," *The New Scientist*, 2 May 1985, p. 38.

Author discusses how science fiction writing came of age in the United States, and its effects upon a generation.

Technological Literacy

Allen, Dwight W., and Lawrence N. McCullough. "Education and Technology: The Changing Basics," *Educational Technology*, January 1980, pp. 47–531.

Proposes that educational technology can have the effect of making education more humane.

Anandam, Kamala, and J. Terence Kelly. "Teaching and Technology: Closing the Gap," *T.H.E. Journal*, November 1982, pp. 84–90.

Suggests practical ways of bringing teaching and technology closer together.

Anderson, Albert A., and Lieselotte Z. Anderson. "The Error of Expectations: Cultural Literacy in the Twenty-First Century," *ADFL Bulletin*, November 1983, Vol. 15, #1.

Examines the realistic expectations of cultural literacy.

Atkinson, Richard C. "Education for an Age of Science," *Science*, 30 March 1984, Vol. 223, #4643.

Bowden, Gordon, T. "Becoming a Scientifically Literate Nation," *Educational Record*, Fall 1982, pp. 5–8.

Calls for cultural reform, both nationally and locally, to improve scientific literacy.

Branscomb, Anne W. "Knowing How to Know," *Science, Technology, & Human Values*, Vol. 6, #36, Summer 1981, pp. 5–9.

Notes the widening gap between experts and the public; defines science literacy in all its aspects; suggests that scientific community must compete for public attention, be "interesting enough and articulate enought to capture" public imagination.

Chen, David, and Ruth Kovik. "Scientific and Technological Education in an Information Society," *Science Education* 68 (4), 1984, pp. 421–426.

Authors examine scientific and technological education through the concept of "culture."

Cutcliffe, Stephen H., and Steven L. Goldman. "Science, Technology, and the Liberal Arts: Report on a National Conference Held at Lehigh University," *Science, Technology, & Human Values* Vol. 10, #1, Winter 1985, pp. 80–87.

Describes Lehigh's activities in this area, and outside contributions to the conference.

Ehrmann, Stephan C. "Technology Could Change the Goals of a College Education . . .," *Educational Technology*, September 1984, pp. 7–12.

Suggests the problems posed by technology may and perhaps should "entail rethinking our roles and our institutions."

Florman, Samuel. "Science for Public Consumption: More than We Can Chew?" *Technology Review*, April 1983, pp. 12–13.

Questions whether "we have been too simplistic in our assumption about science education and the public"; differentiates between knowledge and learning.

Florman, Samuel. "Technological Literacy: An Uneasy Victory," *Technology Review*, July 1982, pp. 6–7.

Refers to Sloan programs; states "Having given up on the idea of creating

humanistically sensitized technologists, the foundation has decided to create technologically sophisticated humanists."

Friedman, Edward A. "Dimensions of Technological Literacy in Liberal Education," *the Forum for Liberal Education*, December 1980, Vol. III, #3, pp. 1–4.

Presents the engineering view of technological literacy in liberal arts education.

Gauld, Colin. "The Scientific Attitude and Science Education: A Critical Reappraisal," *Science Education* 66 (1): 109–121 (1982).

Proposes a reformulated and more acceptable version of the scientific attitude that incorporates the affective domain in relation to science education.

George, Melvin D. "Guest Editorial: Science and Math Preparation—The University's Role," *American Journal of Physics*, 51 (3), March 1983, pp. 207–208.

Author takes position that it is a *sine qua non* for a responsible citizen to hold the ability to "function adequately in the scientific, mathematical, and technological environment of today."

Goldberg, Albert L. "The Eclectic Technologist: Computer Literacy or Technological Literacy?" *Educational Technology*, July 1984, pp. 33–34.

Raises questions on the implications for postsecondary education, teacher and faculty development, integration of knowledge fields and disciplines, etc.

Graham, Patricia Albjerg. "Literacy: A Goal for the Secondary Schools," *Daedalus*, Summer 1981, pp. 119–134.

Provides an historical review of literacy: definitions, purposes, current *raison d'etre*.

Guenther, Raymond. "Forget It! Forget It!" *Phi Delta Kappan*, December 1984, pp. 257–258.

Notes the need to change mindsets more than minds; discusses what it is we really need to learn (and to teach).

Guthrie, John T., and Irwin S. Kirsch. "The Emergent Perspective on Literacy," *Phi Delta Kappan*, January 1984, pp. 351–355.

Proposes a social-interaction perspective on literacy; need for multiple literacies—social, economic and technological.

Illich, Ivan. "Hugh of St. Victor or Science By People," *Bulletin of Science, Technology, and Society*, Vol. 2, 1982, pp. 513–524.

Relates the life of the 12th century thinker and compares Hugh's philosophy with the "research by the people" concept.

Lazerson, Marvin, Judith Block Mclaughlin, and Bruce McPherson. "Learning and Citizenship: Aspirations for American Education," *Daedalus*, Fall 1984, pp. 59–74.

Authors discuss the concept "learning involves making meaning"; examines current American education and its needs.

Moberg, Thomas. "Computers as a Resource for the Liberal Arts," *The Weaver of Information and Perspectives on Technological Literacy*, Spring 1983, Vol. 1, #2, p. 12.

"The Weaver" is a Sloan Foundation publication.

Molnar, Andrew R. "The Search for New Intellectual Technologies," *T.H.E. Journal*, September 1982, pp. 104–112.

Discusses the appropriate uses of the new technologies for higher education.

Perry, Mike. "A Survey of Undergraduate Science and Technology Education for Non-Specialists," *Update*, Association of American Colleges, March 1985, Vol. 8, #6, pp. 1–4.

Follow-up research to the book *Science for Non-Specialists: The College Years* (on "Well-Read List").

Roy Rustum. "Editorial: STS—Core of Technological Literacy," *Bulletin of Science, Technology, & Society*, Vol. 2, 1982, pp. 289–290.

Warns that the present concern regarding technological literacy is in danger of being a "faddish response" to a serious problem.

Shamos, Morris H. "Guest Editorial: Exposure to Science vs. Scientific Literacy," *Journal of Computers, Science, and Technology*, March/April 1984, pp. 333–334.

Warns against confusing "exposure to science with understanding it."

Turner, Judith Axler. "A Personal Computer for Every Freshman: Even Faculty Skeptics Are Now Enthusiasts," *The Chronicle of Higher Education*, Vol. XXIX, #23, Feb. 20, 1985, pp. 1, 14–15.

Truxal, John G. "Technology—Omnipresent, Transdisciplinary," *Educational Horizons*, Fall 1983, pp. 12–14.

Provides a perspective to examine what basic technological concepts should be taught.

Technology

Baruch, Jordan J. "The Culture of Science and Technology," *Science*, 6 April 1984, Vol. 224, #4644.

Explains the near polarity of the cultures of science and technology and resulting ramifications.

Ferguson, Eugene S. "The Mind's Eye: Nonverbal Thought in Technology," *Science*, 26 August 1977, Vol. 197, #4306.

Discusses the possibility of different ways of thinking that occur when one works with technological instruments.

Freeman, Christopher. "Prometheus Unbound," *Futures*, October 1984, pp. 494–507.

Good working definition of a technological revolution.

Friedman, Edward A. "Technology As an Academic Discipline," *Engineering Education*, December 1980, pp. 211–216.

Proposes that the subject of technology should be incorporated into general education.

Grove, J.W. "Science as Technology: Aspects of a Potent Myth," *Minerva*, Vol. 28, #2, Spring 1980, pp. 292–312.

Dispels myth that science and technology have become indistinguishable.

Hamburg, David A. "Science and Technology in a World Transformed," *Science*, Vol. 224, #4653, June 1984.

Speaks of the fundamental values of freedom, curiosity, opportunity, diversity, excellence and human decency as guides for our evolving institutions in a transforming world.

Landes, David. "The Creation of Knowledge and Technique: Today's Task and Yesterday's Experience," *Daedalus*, Winter 1980, pp. 111–120.

Education in technology for the less developed countries.

Poirier, Richard. "Literature, Technology, People," *Daedalus*, Fall 1982, pp. 61–74.

To the three terms of the title, the author adds the concept of power, and explores the work of knowing.

Roy, Rustum. "The Reformation of Science," *Bulletin of Science, Technology, and Society*, Vol. 1, 1981, pp. 3–9.

Author calls for an "integrative holistic science done in constant interaction with society."

von Puttkamer, Jesco. "The Future: Do We Have a Choice?" *Educational Leadership*, September 1983, pp. 6–8.

Speaks of today's world condition, scene of rapid technological, social and economic change; proposes four theses for comprehension of the divisions between technology and humanism.

Weisskopp, Victor F. "The Double-Edged Sword Called Technology," *Bulletin of Atomic Scientists*, 36, April 1980, pp. 17–21.

Cites need for a more popularly controlled technology; a new step toward humanization of industrial processes.

Wolcott, Harry F. "Is There Life After Technology? Some Lessons on Change," *Educational Technology*, May 1981, pp. 24–28.

Examines aspects of human reactions to change.

Values/Ethics

Bazelon, David L. "Governing Technology: Values, Choices, and Scientific Progress," *Technology in Society*, 1983, Vol. 5, pp. 15–25.

Comments on judicial review of governmental regulation of public health and safety; discusses role of common law in providing remedies in the absence of government regulation.

Bennett, William J. "The Humanities, The Universities, and Public Policy," *Educational Record*, Summer 1981, pp. 30–34.

States that the task for the humanist is to "provide continuity, educate each generation about the intellectual, spiritual, moral, and political birth to which it is heir . . . from which . . . public policy must flow."

Blunden, Margaret. "Technology and Values: Problems and Options," *Futures*, August 1984, pp. 418–424.

Presents the need for an appropriate epistemology to deal with the interaction of science, technology and values.

Cox, Harvey G. "Tradition and the Future: I and II" *Christianity and Crisis*, October 2, 1967, pp. 218–220 (I); October 16, 1967, pp. 227–231 (II).

Discusses quality of future life; notes need for how individual and political decisions will be made.

La Follette, Marcel C. "Editorial: Forging the Links," *Science, Technology, & Human Values*, Winter 1984, Vol. 9, #1, pp. 3–6

Addresses regulatory decision-making, institutional values of science and the law, conflicts in social values.

Salk, Jonas. "Merging Intuition and Reason," *Technological Forecasting and Social Change*, Vol. 26, #2, September 1984, pp. 167–170.

Proposes a reconciliation of the intuitive and reasoning powers of human beings to produce a new ethic/morality, for the evolutionary changes occurring.

Zeidler, Dana L. "Moral Issues and Social Policy in Science Education: Closing the Literacy Gap," *Science Education*, 1984, Vol. 68, #4, pp. 411–419.

Calls for reform in science education; inclusion of moral and ethical issues in interdisciplinary science curriculum.

Fee, Elizabeth. "Is Feminism a Threat to Scientific Objectivity?" *International Journal of Women's Studies*, Vol. 4, #4, pp. 378–392.

Questions whether there is a conflict between women's values and the values of science.

Fausto-Sterling, Anne. "Women and Science," *Women's Studies International Quarterly*, 1981, Vol. 4, #1, pp. 41–49.

Examines the issues of why there are not more women scientists, and how scientific inquiry and subject matter would change if the participation were gender equal.

Keller, Evelyn Fox. "Women and Basic Research: Respecting the Unexpected," *Technology Review*, November/December 1984, pp. 44–47.

Discusses a gender-free approach to scientific research that respects nature in its diversity.

Manthorpe, Catherine. "Feminists Look at Science," *The New Scientist*, 7, March 1985.

Notes the contribution of feminist interest in, and criticism of, science.

Paltiel, Freda L. "Shaping Futures for Women," *Women's Studies International Quarterly*, 1981, Vol. 4, #1, pp. 13–25.

Basic premise: "every adult needs three anchors—work, family, and friendship"; examines role symmetry in the post industrial society.

Rothschild, Joan A. "A Feminist Perspective on Technology and the Future," *Women's Studies International Quarterly*, 1981, Vol. 4, #1, pp. 65–73.

Explores the concept of *femina fabera*; women's past, present and future contributions to technology.

Zimmerman, Jan. "Technology and the Future of Women: Haven't We Met Somewhere Before?" *Women's Studies International Quarterly*, 1981, Vol. 4, #3, pp. 355–367.

Examines the impact of four technological areas on women's lives in the next 20 years—computers, communications, energy production and genetic engineering.

Introduction to Syllabi Readings

This list of readings was compiled from the syllabi that were submitted by faculty in response to CIC's questionnaire. The initial list included well over 300 different titles. The titles were submitted to the following qualifications: (1) discipline-specific works, published prior to 1975, were generally omitted, on the premise that faculty are familiar with the material of their field;

and (2) special attention was given to more current writings for updating purposes.

Syllabi content determined the categorization of the titles. In most cases titles appearing under specific disciplinary areas were offered by faculty working in that discipline (anthropology titles were from anthropology courses taught by anthropologists). However, interdisciplinary courses were not always so clearly defined and a certain amount of personal judgment was employed. The use of biographies, drama, fiction and other somewhat ambiguous titles defied neat categorization into disciplines and were therefore given their own categories.

Only 32 titles were repeated on this list; their frequency is noted in brackets following the author's name, just prior to the title. Only five titles appeared five times; six titles, three times; and 21 titles, two times. (These titles are listed below, for your interest.)

One purpose of this material is to provide the reader with a sense of what "kinds" of reading materials are being used in courses that include a technological view. Through literature, as one example, one might question the appropriate utilization of advanced warfare technology that the Connecticut Yankee brought to King Arthur's court.

The reader might want to look at Giere's book, *Understanding Scientific Reasoning*, cited on page 61. This book was written for use as a textbook using philosophy as a means to understand the social impact and ramifications of technology.

List of Repeated Titles

REPEATED FIVE TIMES:

Bolter, David. *Turing's Man*
Ellul, Jacques. *The Technological Society*
Florman, Samuel. *The Existential Pleasures of Engineering*
Kidder, Tracy. *The Soul of a New Machine*
Pirsig, Robert. *Zen and the Art of Motorcycle Maintenance*

REPEATED THREE TIMES:

Toffler, Alvin. *Future Shock*
Kuhn, Thomas. *The Structure of Scientific Revolutions*
Marx, Leo. *The Machine in the Garden*
Snow, C.P. *The Two Cultures*
Teich, Albert (ed.). *Technology and Man's Future*
Weizenbaum, Joseph. *Computer Power and Human Reason*

REPEATED TWICE:

Billington, David. *The Tower and the Bridge*
Burke, James. *Connections*
Burke, John. *Technology and Change*

Cardwell, Donald. *Turning Points in Western Technology*
Cipolla, Carlo. *Guns, Sails, and Empires*
Cooley, Mike. *Architect or Bee?*
Florman, Samuel. *Blaming Technology*
Geis, Larry. *Worlds Beyond*
Giere, Ronald. *Understanding Scientific Reasoning*
Graham, Neill. *The Mind Tool*
Ihde, Don. *Technics and Praxis*
Jastrow, Robert. *The Enchanted Tool*
Judson, Horace. *Search for Solutions*
Levin, Ira. *This Perfect Day*
Marcuse, Herbert. *One Dimensional Men*
Mumford, Lewis. *The Myth of the Machine*
Naisbitt, John. *Megatrends*
Noble, David. *America by Design*
Toffler, Alvin. *The Third Wave*
Trescott, Martha (ed.). *Dynamo and Virgin Revisited*
Vonnegut, Kurt. *Player Piano*

List of Readings from Syllabi

Anthropology

Cipolla, Carlo, *Clocks and Culture, 1300–1700* (New York: Walker, 1967).

Gutman, Herbert G., *Work, Culture, and Society in Industrializing America* (New York: Knopf, 1976).

Isaac, Glenn L., and Elizabeth R. McCown (eds.), *Human Origins: Louis Leakey and the East African Evidence* (Menlo Park, Cal.: W.A. Benjamin, 1976).

Lowe, Donald, *History of Bourgeois Perception* (Chicago: University of Chicago Press, 1982).

Zerbavel, Eviatar, *Hidden Rhythms: Schedules and Calendars in Social Life* (Chicago: University of Chicago Press, 1981).

Biography

Appleman, Phillip, *Darwin* (New York: Norton, 1979).

Drake, Stillman, *Galileo at Work: His Scientific Biography* (Chicago: University of Chicago Press, 1978).

Heydenreich, Ludwig H., *Leonardo, the Inventor* (New York: McGraw-Hill, 1980).

Wachhorst, Wyn, *Thomas Alva Edison, an American Myth* (Cambridge, Mass.: M.I.T. Press, 1981).

Wolfe, Tom, *The Right Stuff* (New York: Bantam, 1979).

Biology

Darwin, Charles Robert, *The Descent of Man and Selection in Relation to Sex*, 2nd Edition (New York: Wheeling Publishing Co. [pref. 1874]).

Folsome, Clair Edwin, *The Origin of Life: A Warm Little Pond* (San Francisco: W.H. Freeman, 1979).

Biotechnology

David, A.J., and P.S. Stephen, *The Recombinant DNA Debate* (Englewood Cliffs, N.J.: Prentice-Hall, 1979).

Drlica, Karl, *Understanding DNA and Gene Cloning: A Guide for the Curious* (New York: Wiley, 1984).

Facklam, Margery, and Howard Facklam, *From Cell to Clone: The Story of Genetic Engineering* (New York: Harcourt Brace Janovich, 1979).

Grobstein, Clifford, *A Double Image of the Double Helix: The Recombinant DNA Debate* (San Francisco: W.H. Freeman, 1979).

Beranek, William, and Gustave Ranis (eds.), *Science, Technology, and Economic Development: A Historical and Comparative Study* (New York: Praeger Publishers, 1978).

Black Studies

Curtis, James L., *Blacks, Medical Schools, and Society* (Ann Arbor: University of Michigan Press, 1971).

Griffin, John Howard, *Black Like Me* (Boston: Houghton-Mifflin, 1961).

Haller, John S., *Outcasts from Evolution: Scientific Attitudes of Racial Inferiority, 1859–1900* (New York: W.W. Norton, 1977 [orig. ed. 1974]).

Ivie, Sylvia Drew, "Health Care Access—If You're Black* (*Brown, Native American, Asian . . .) Stay Back," *Health Law Project Library Bulletin* III, 1978 pp. 1–9.

Jones, James H., *Bad Blood: The Tuskegee Syphilis Experiment* (New York: The Free Press, 1981).

Chemistry

Hill, John William, *Chemistry for Changing Times* (Minneapolis: Burgess Publishing Company, 1975).

Julian, R.M., *A Primer of Drug Action* (San Francisco: W.H. Freeman, 1981).

Computer Science

Brunham, D., *The Rise of the Computer State* (New York: Random House, 1980).

Feigenbaum, E., and P. McCorduck. *The Fifth Generation* (Reading, Mass.: Addison-Wesley, 1983).

Forester, T. (ed.), *The Information Technology Revolution* (Cambridge, Mass.: M.I.T. Press, 1985).

Frates, J., and W. Moldrup, *Computers and Life* (Englewood Cliffs, N.J.: Prentice-Hall, 1983).

Friedrichs, G., and A. Schall (eds.), *Microelectronics and Society* (New York: The New American Library, 1982).

Papert, S., *Mindstorms* (New York: Basic Books, 1980).

Drama

Rice, Elmer L., *The Adding Machine* (Garden City, N.Y.: Doubleday, Page and Co., 1923).

Shakespeare, William (G. Blakemore Evans, ed.), *Romeo and Juliet* (Cambridge: Cambridge University Press, 1984).

Sophocles (Dudley Filts and Robert Fitzgerald, eds.), *The Oedipus Cycle* (New York: Harcourt Brace and World, 1949).

Willett, John, and Ralph Manheim (eds.), "Galileo" in *Collected Plays of Bertolt Brecht* (New York: Pantheon, 1970).

Economics

Barnet, Richard J., *The Lean Years: Politics in the Age of Scarcity* (New York: Simon & Schuster, 1980).

Hartwell, R.M. (ed.), *The Causes of the Industrial Revolution in England* (London: Methuen, 1967).

Lerza, Catherine, and Michael Jacobson, *Food For People, Not For Profit: A Source Book on the Food Crisis* (New York: Ballantine Books, 1975).

North, Douglass C., and Robert P. Thomas, *The Rise of the Western World: A New Economic History* (Cambridge: Cambridge University Press, 1973).

Weisskopf, Walter A., *Alienation and Economics* (New York: Dutton, 1971).

Engineering

Billington, David, [2] *The Tower and the Bridge* (New York: Basic Books, 1983).
Total of 1800 slides, documented and organized; lecture notes *Structures and the Urban Environment* (bound, 400 pages), and additional materials, *Structural Studies* (bound, 200 pages, with quantitative analyses and homework problems); available from David Billington and Robert Mark.

Florman, Samuel, [2] *Blaming Technology: An Irrational Search for Scapegoats* (New York: St. Martin's Press, 1981).

Florman, Samuel, [5] *The Existential Pleasure of Engineering* (New York: St. Martin's Press, 1976).

Hindle, Brooke, *Emulation and Invention* (New York: New York University Press, 1981).

Martin, Mike W., and Roland Schinzinger, *Ethics in Engineering* (New York: McGraw-Hill, 1983).

Environment

Brown, Michael Harold, *Laying Waste: The Poisoning of America by Toxic Chemicals* (New York: Pantheon Books, 1980).

Dales, John Harkness, *Pollution, Property, and Prices* (Toronto: University of Toronto Press, 1970).

Fowler, John M., *Energy and the Environment* (New York: McGraw-Hill, 1984).

Gabor, Dennis, *Beyond the Age of Waste, A Report to the Club of Rome* (Elmsford, N.Y.: Pergamon, 1981).

Lappe, Frances Moore, and Joseph Collins, *Hunger: Ten Myths*, 4th Edition (San Francisco: Institute for Food and Development Policy, 1982).

Leiss, William, *The Domination of Nature* (New York: G. Braziller, 1972).

Miller, G. Tyler, Jr., *Living in the Environment, Concepts, Problems, and Alternatives* (Belmont, Cal.: Wadsworth Publishing Co., 1975).

Morrison, James W., *The Complete Energy Savings Handbook for Homeowners* (New York: Harper and Row, 1979).

Ophulus, William, *Ecology and the Politics of Scarcity: Prologue to a Political Theory of the Steady State* (San Francisco: W.H. Freeman, 1977).

Regan, Tom (ed.), *Earthbound: New Introductory Essays in Environmental Ethics* (Philadelphia: Temple University Press, 1984).

Rosenbaum, Walter, *Environmental Politics and Policy* (New York: Praeger Press, 1985).

Schaeffer, Francis A., *Pollution and the Death of Man: The Christian View of Ecology* (Wheaton, Ill.: Tyndale House, 1970).

Simon, Julian L., and Herman Kahn, *The Resourceful Earth: A Response to Global 2000* (Oxford: B. Blackwell, 1984).

Ethics

Bronowski, Jacob, *Science and Human Values* (New York: Harper and Row, 1972).

Brown, E. Richard, *Rockefeller Medicine Men: Medicine and Capitalism in America* (Berkeley: University of California Press, 1979).

Hapgood, David, *The Screwing of the Average Man* (Garden City, N.Y.: Doubleday, 1974).

Howard, Ted, and Jeremy Rifkin, *Who Should Play God: The Artificial Creation of Life and What It Means for the Future of the Human Race* (New York: Delacorte Press, 1977).

MacIntyre, Alasdair C., *After Virtue: A Study in Moral Theory* (Notre Dame, Ind.: University of Notre Dame Press, 1981).

Marcuse, Herbert, [2] *One Dimensional Men* (Boston: Beacon Press, 1966).

Nicholson, Heather Hohnston and Ralph L. Nicholson, *Distant Hunger: Agriculture, Food, and Human Values* (West Lafayette, Ind.: Purdue University Press, 1979).

Pirsig, Robert M., [5] *Zen and the Art of Motorcycle Maintenance: An Inquiry into Values* (New York: Morrow, 1974).

Ray, Oakley Stern, *Drugs, Society, and Human Behavior,* 3rd Edition (St. Louis: Mosby, 1983).

Richards, John (ed.), *Recombinant DNA: Science, Ethics, and Politics* (New York: Academic Press, 1978).

Rifkin, Jeremy, in collaboration with Nicanor Perlas, *Algeny* (New York: Viking Press, 1983).

Roubiczek, Paul, *Ethical Values in the Age of Science* (Cambridge: Cambridge University Press, 1969).

Wade, Nicholas, *The Ultimate Experiment: Man-Made Evolution* (New York: Walker, 1977).

Ethics, Biomedical

Beauchamp, Tom L., and James F. Childress. *Principles of Biomedical Ethics*, 2nd Edition (New York: Oxford University Press, 1983).

Harron, Brownside, and Beauchamp, Tom L., *Health and Human Values* (New Haven: Yale University Press, 1983).

Fiction

Huxley, Aldous, *Brave New World* (London: Chatto and Windus, 1970).

Levin, Ira, [2] *This Perfect Day* (New York: Random House, 1970).

Marlowe, Christopher, *Dr. Faustus* (New York: Thistle Press, 1966).

Shelley, Mary Wollstonecraft, *Frankenstein* (Chicago: University of Chicago Press, 1982).

Steiner, George, *Language and Silence: Essays on Language, Literature, and the Inhuman* (New York: Atheneum, 1967).

Swift, Jonathan, *Gulliver's Travels* (London: The Folio Society, 1965).

Twain, Mark, *A Connecticut Yankee in King Arthur's Court* (New York: Norton Press, 1982).

Vonnegut, Kurt, [2] *Player Piano* (New York: Holt, Rinehart and Winston, 1966).

Futuristics

Huddle, Norie, *Surviving: The Best Game on Earth* (New York: Schocken Books, 1983).

Naisbitt, John [2] *Megatrends* (New York: Warner Books, 1982).

Toffler, Alvin, [3] *Future Shock* (New York: Bantam Books, 1971).

Toffler, Alvin, [2] *The Third Wave* (New York: Morrow, 1980).

World Future Society, *The Futurist* (Washington: World Future Society, 1967).

History

Bailyn, Bernard, et. al., *The Great Republic: A History of the American People.* (Boston: Little, Brown, 1977).

Blum, John M., et. al., *The National Experience: A History of the United States,* 5th edition (New York: Harcourt Brace Jovanovich, 1981).

Burke, James, [2] *Connections* (Boston: Little, Brown, 1978).

Cipolla, Carlo M., [2] *Guns, Sails, and Empires: Technological Invention and the Early Phases of European Expansion* (out of print, Prologue and Chapter II used) (New York: Pantheon Books, 1965).

Gimpel, Jean, *Medieval Machine: The Industrial Revolution of the Middle Ages* (New York: Holt, Rinehart and Winston, 1976).

Headrick, Daniel R., *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century* (New York: Oxford University Press, 1981).

Hobhouse, Christopher, *1851 and the Crystal Palace* (New York: E.P. Dutton and Co., Inc., 1937).

Landes, David S., *The Unbound Prometheus: Technology Change and Industrial Development in Western Europe from 1750 to the Present* (Cambridge: Cambridge University Press, 1969).

Le Goff, Jacques, *Farm Work and Culture in the Middle Ages* (Chicago: University of Chicago Press, 1980).

McNeill, William H., *The Pursuit of Power: Technology, Armed Force, and Society Since A.D. 1000* (Chicago: University of Chicago Press, 1982).

Mowry, George E., and Blaine A. Brownell, *The Urban Nation, 1920–1980* (New York: Hill and Wang, 1981).

Smith, Merritt Roe, *Harper's Ferry Armory and the New Technology: The Challenge of Change* (Ithaca, N.Y.: Cornell University Press, 1977).

White, Lynn Townsend, *Machina ex Deo: Essays in the Dynamism of Western Culture* (Cambridge, Mass.: M.I.T. Press, 1968).

White, Lynn Townsend. *Medieval Technology and Social Change* (New York: Oxford University Press, 1966).

Wiebe, Robert H., *The Search for Order, 1877–1920* (Westport, Conn.:Greenwood Press, 1980).

History of Medicine

Leavitt, Judith Walzer, and Ronald L. Numbers (eds.), *Sickness and Health in America: Readings in the History of Medicine and Public Health* (Madison, Wis.: University of Wisconsin Press, 1978).

Reverby, Susan, and David Rosner (eds.), *Health Care in America: Essays in Social History* (Philadelphia: Temple University Press, 1979).

Rosenberg, Charles E., *The Cholera Years: The United States in 1832, 1849, and 1866* (Chicago: University of Chicago Press, 1962).

Shryock, Richard H., *Medicine and Society in America* (New York: New York University Press, 1960).

Vogel, Mossis J., and Charles E. Rosenberg (eds.), *The Therapeutic Revolution: Essays in the Social History of American Medicine* (Philadelphia: University of Pennsylvania Press, 1979).

History of Science

Kevles, Daniel J., *The Physicists: The History of a Scientific Community in Modern America* (New York: Vintage Books, 1979).

Mass Communications

Black, Jay, and Frederick C. Whitney, *Introduction to Mass Communication*, (Dubuque, Iowa: Wm. C. Brown Company, 1983).

Cirino, Robert, *Don't Blame the People: How the News Media Use Bias, Distortion, and Censorship to Manipulate Public Opinion* (New York: Random House, 1972).

Ewen, Stuart, *Captains of Consciousness: Advertising and the Social Roots of the Consumer Culture* (New York: McGraw-Hill, 1976).

McLuhan, Marshall, *The Gutenberg Galaxy: The Making of Typographic Man* (New York: The New American Library, 1969).

McLuhan, Marshall, *The Medium is the Massage* (New York: Penguin Press, 1967).

McLuhan, Marshall, *Understanding Media: Extensions of Man* (New York: McGraw-Hill, 1964).

Rissover, F., and D.S. Birch, *Mass Media and the Popular Arts*, 2nd Fdition (New York: McGraw-Hill, 1971).

Stearn, G.E. (ed.), *McLuhan: Hot and Cool* (New York: Dial Press, 1967).

Williams, Frederick, *The Communications Revolution*, Revised Edition (New York: New American Library, 1982).

Medicine

Culyer, A.J., and B. Horisberger (eds.), *Economic and Medical Evaluation of Health Care Technologies* (Berlin: Springer-Verlag, 1983).

McNeil, B.J., and E.G. Cravalho (eds.), *Critical Issues in Medical Technology* (Boston: Auburn House, 1982).

Natural Sciences

Judson, Horace Freeland, [2] *Search for Solutions* (accompanied by a series of 20-minute videotapes) (New York: Holt, Rinehart and Winston, 1980).

Nuclear Issues

Cochran, Thomas B., William M. Arkin and Milton M. Hoenig, *Nuclear Weapons Databook, Vol. I: US Nuclear Forces and Capabilities* (New York: Ballinger, 1984).

Dennis, Jack, *The Nuclear Almanac* (New York: Addison-Wesley, 1984).

Freedman, Lawrence, *The Evolution of Nuclear Strategy* (New York: St. Martin's Press, 1983).

Gilpin, Robert, *American Scientists and Nuclear Weapons Policy* (Princeton: Princeton University Press, 1962).

Glasstone, Samuel, and Philip J. Dolan, *The Effects of Nuclear Weapons*, 3rd Edition (Washington: U.S. Government Printing Office, 1977).

Jungk, Robert, *Brighter than a Thousand Suns* (New York: Harcourt Brace, 1958).

Legault, Albert, and George Lindsey, *The Dynamics of Nuclear Balance*, Revised Edition (Ithaca, N.Y.: Cornell University Press, 1976).

Schroeer, Dietrich, *Science, Technology, and the Nuclear Arms Race* (New York: Wiley, 1984).

Smoke, Richard, *National Security and the Nuclear Dilemma* (New York: Addison Wesley, 1984).

Talbott, Strobe, *Deadly Gambits: The Reagan Administration and the Stalemate in Nuclear Arms Control* (New York: Knopf, 1984).

Tobias, Sheila, Peter Goudinoff, Stefan Leader and Shelah Leader. *People's Guide to National Defense: What Kinds of Guns Are They Buying for Your Butter?* (New York: Morrow, 1983).

Tobias is a "people's" guide to weaponry. Lead author is an active feminist who strongly believes that common folk can, and ought to, understand the weapons and lingo of war and warriors.

Tsipis, Kosta, *Arsenal: Understanding Weapons in the Nuclear Age* (New York: Simon & Schuster, 1983).

Walzer, Michael, *Just and Unjust Wars* (New York: Basic Books, 1977).

Philosophy

Adler, Mortimer Jerome, *A Vision of the Future: Twelve Ideas for A Better Life and a Better Society* (New York: Macmillan, 1984).

Anderson, Norman, *Issues of Life and Death* (Downers Grove, Ill.: Inter-Varsity Press, 1976).

Borchert, Donald M. and David Stewart (eds.), *Being Human in a Technological Age* (Columbus: University of Ohio Press, 1979).

Descartes, René (John Veitch, translator), *A Discourse on Method and Selected Writings* (New York: Dutton, 1951).

Ellul, Jacques, [5] *The Technological Society* (New York: Vintage Press, 1964).

Feyerabend, Paul, *Science in a Free Society* (London: NLB, 1978).

Giere, Ronald N., [2] *Understanding Scientific Reasoning*, 2nd Edition (New York: Holt, Rinehart and Winston, 1984).

Hacking, Ian (ed.), *Scientific Revolutions* (New York: Oxford University Press, 1981).

Heilbroner, Robert L., *An Inquiry Into the Human Prospect* (New York: Norton, 1980).

Ihde, Don, *Existential Technics* (Albany, N.Y.: State University of New York Press, 1982).

Ihde, Don, [2] *Technics and Praxis* (Boston: D. Reiden Publishing Co., 1979).

Kolakowski, Leszek (Norbert Guterman, translator), *The Alienation of Reason: A History of Positivist Thought* (Garden City, N.Y.: Doubleday, 1968).

Kuhn, Thomas S., *The Copernican Revolution: Planetary Astronomy in the Development of Western Thought* (Cambridge: Harvard University Press, 1957).

Kuhn, Thomas S., [3] *The Structure of Scientific Revolutions*, 2nd Edition, Enlarged (Chicago: University of Chicago Press, 1970).

Lewis, C.S., *The Abolition of Man* (New York: Macmillan, 1978).

Marlowe, Christopher (Havelock Ellis, ed.), *The Tragical History of Dr. Faustus* (New York: Heritage Press, 1966).

Norman, Richard J., *The Moral Philosophers* (New York: Oxford University Press, 1983).

Price, Derek John deSolla. *Little Science, Big Science* (New York: Columbia University Press, 1963).

Revel, Jean Francois, *Without Marx or Jesus: The New American Revolution Has Begun* (New York: Dell Publishing, 1972).

Scheffler, Israel, *Science and Subjectivity* (Indianapolis: Hackett Publishing Co., 1982).

Snow, C.P., [3] *The Two Cultures (and the Scientific Revolution): and a Second Look* (Cambridge: University of Cambridge Press, 1964).

Spragens, Thomas A., *The Irony of Liberal Reason* (Chicago: University of Chicago Press, 1981).

Ziman, John M., *Public Knowledge: An Essay Concerning the Social Dimension of Science* (Cambridge: Cambridge University Press, 1968).

Physics

Freeman, Ira M., *Physics Made Simple* (Garden City, N.Y.: Doubleday, 1965).

Political Science

Ackerman, Bruce A., and William T. Hassler, *Clean Coal/Dirty Air (or How the Clean Air Act Became a Multibillion Dollar Bail-Out for High-Sulphur Coal Producers and What Should be Done About It)* (New Haven: Yale University Press, 1981).

Anderson, James E., *Cases in Public Policy Making* (New York: Praeger Press, 1976).

Dickson, David, *The Politicis of Alternative Technology* (New York: Universe Books, 1975).

Fromm, Erich, *Marx's Concept of Man* (New York: F. Unger, 1966).

Gilpin, Robert, and Christopher Wright (eds.), *Scientists and National Policy-Making* (New York: Columbia University Press, 1964).

Greenberg, Daniel S., *The Politics of Pure Science* (New York: New American Library, 1968).

Gryski, Gerard S., *Bureaucratic Policy Making in a Technological Society* (Cambridge, Mass.: Schenkman Publishing Co., 1981).

Holloway, David, *The Soviet Union and the Arms Race*, 2nd Edition (New Haven: Yale University Press, 1983).

Illich, Ivan, *Tools for Conviviality* (New York: Harper & Row, 1973).

Kamenka, Eugene (ed.), *The Portable Karl Marx* (New York: Viking Press, 1983).

Kingdon, John W., *Agendas, Alternatives, and Public Policy* (Boston: Little, Brown, 1984).

Kuehn, Thomas J., and Lan L. Porter (eds.), *Science, Technology, and National Policy* (Ithaca, N.Y.: Cornell University Press, 1981).

Lambright, Henry W., *Governing Science and Technology* (New York: Oxford University Press, 1976).

Marx, Leo [3] *The Machine in the Garden: Technology and the Pastoral Ideal in America* (New York: Oxford University Press, 1964).

Noble, David F., [2] *America By Design* (New York: Knopf, 1977).

Redman, Eric, *The Dance of Legislation* (New York: Simon and Schuster, 1973).

Roszak, Theodore, *Where the Wasteland Ends: Politics and Transcendence in Postindustrial Society* (Garden City, N.Y.: Doubleday, 1972).

Sapolsky, Harvey M., *The Polaris System Development* (Cambridge: Harvard University Press, 1972).

Schulman, Paul, *Large-Scale Policy-Making* (New York: Elsevier N. Holland, 1980).

Smoke, Richard, *National Security and the Nuclear Dilemma* (Reading, Mass.: Addison-Wesley Publishing Co., 1984).

Wildavsky, Aaron, *Politics of the Budgetary Process*, 4th Edition (Boston: Little, Brown, 1984).

Zinberg, Dorothy S., *Uncertain Power: The Struggle for a National Energy Policy* (Elmsford, N.Y.: Pergamon Press, 1983).

Programming

Hare, Robert, *Personal Computing, BASIC Programming on the TRS-80* (Monterey, Cal.: Brooks/Cole Publishing, 1984).

Psychology

Appignanesi, Richard, *Freud for Beginners* (New York: Pantheon Books, 1979).

Frankl, Victor Emil, *Man's Search for Meaning* (New York: Pocket Books, 1972).

Freud, Sigmund, *Civilization and Its Discontents* (New York: W.W. Norton, 1962).

Freud, Sigmund, *Psychopathology of Everyday Life* (New York: Macmillan Co., 1917).

Maier, Norman, Raymond F. and Gertrude Castellman Verser, *Psychology in Industrial Organizations* (Boston: Houghton Mifflin Co., 1982).

Skinner, B.F., *Walden Two* (New York: Macmillan Co., 1972).

Taylor, Frederick W., *The Principles of Scientific Management* (New York: Harper, 1947).

Science Fiction

Le Guin, Ursula K., *The Dispossessed* (New York: Harper and Row, 1974).

Miller, Fred D., Jr., and Nicholas D. Smith, *Thought Probes: Philosophy through Science Fiction* (New York: Prentice-Hall, 1982).

Piercy, Marge, *Woman on the Edge of Time* (New York: Knopf, 1976).

Sociology

Barnes, Barry, and David Edge (eds.), *Science in Context: Readings in the Sociology of Science* (Cambridge, Mass.: M.I.T. Press, 1982).

Edwards, R., *Contested Terrain: The Transformation of the Workplace in the Twentieth Century* (New York: Basic Books, 1979).

Etzioni, Amitai, *An Immodest Agenda: Rebuilding America Before the 21st Century* (New York: New Press, 1983).

Linder, Steffan B., *The Harried Leisure Class* (New York: Columbia University Press, 1970).

Merton, Robert K., *The Sociology of Science* (Chicago: University of Chicago Press, 1973).

Thrall, Charles A., and Jerold M. Starr (eds.), *Technology, Power, and Social Change* (Washington: Heath & Co., 1972).

Turkle, Sherry, [3] *The Second Self: Computers and the Human Spirit* (New York: Simon and Schuster, 1984).

Space

Geis, Larry et. al. (eds.), [2] *Worlds Beyond* (Berkeley, Cal.: And/Or Press, 1978).

Systems

Levin, Richard I. et. al., *Quantitative Approaches to Management*, 5th Edition (New York: McGraw-Hill, 1982).

Shelley, Gary B., and Thomas J. Cashman, *Business Systems Analysis and Design* (Fullerton, Cal.: Anaheim Publishing Company, 1975).

Technology

Arbib, Michael, *Computers and the Cybernetic Society*, 2nd Edition (New York: Academic Press, 1984).

Ayres, Robert U., and Steven M. Miller, *Robotics: Applications and Social Implications* (New York: Ballinger Press, 1983).

Bell, Daniel, *Post-Industrial Society* (New York: Basic Books, 1973).

Bolter, J.D., [5] *Turing's Man: Western Culture in the Computer Age* (Chapel Hill, N.C.: The University of North Carolina, 1984).

Burke, John G., and Marshall C. Eakin, [2] *Technology and Change* (San Francisco: Boyd and Fraser Publishing Co., 1979).

Bush, Vannevar, *Science, the Endless Frontier: A Report to the President* (Washington: U.S. Government Printing Office, 1945).

Cardwell, Donald Stephen Lowell, [2] *Turning Points in Western Technology* (New York: Science History Publishers, 1972).

Cooley, Mike, [2] *Architect or Bee? The Human/Technological Relationship* (Slough, Va.: Langley Technical Services, 1980).

de Sola Pool, Ithiel, *Technologies for Freedom* (Cambridge, Mass.: Harvard-Belknap, 1983).

Devore, Paul W., *Technology, an Introduction* (Worcester, Mass.: Davis Publications, Inc., 1980).

Douglas, Jack D., *Freedom and Tyranny: Social Problems in a Technological Society* (Cambridge, Mass.: M.I.T. Press, 1970).

Douglas, Mary, and Aaron Wildavsky, *Risk and Culture* (Berkeley, Cal.: University of California Press, 1982).

Evans, Christopher, *The Micro Millenium* (New York: Viking Press, 1980).

Fallows, James M., *National Defense* (New York: Random House, 1981).

Fischer, Robert B., *Science, Man, & Society*, 2nd Edition (Philadelphia: W.B. Saunders, 1975).

Forester, Tom (ed.), *The Microelectronics Revolution* (Cambridge, Mass.: M.I.T. Press, 1981).

Frude, Neil, *The Intimate Machine: Close Encounters with Computers and Robots* (New York: New American Library, 1983).

Gendron, Bernard, *Technology and the Human Condition* (New York: St. Martin's Press, 1977).

Graham, Neill, [2] *The Mind Tool*, 2nd Edition (St. Paul: West Publishing Co., 1980).

Jastrow, Robert, [2] *The Enchanted Loom: Mind in the Universe* (New York: Simon and Schuster, 1981).

Jungk, Robert, *The New Tyranny: How Nuclear Power Enslaves Us* (New York: F. Jordan Books/Grosset and Dunlap, 1979).

Kidder, Tracy, [5] *Soul of a New Machine* (Boston: Little, Brown, 1981).

Kuehn, Thomas J., and A.L. Porter, *Science, Technology, and National Policy* (Ithaca, N.Y.: Cornell University Press, 1981).

Leibniz, G.W., and Samuel Clarke (H.G. Alexander, ed.), *The Leibniz-Clarke Correspondence* (Manchester: Manchester University Press, 1956).

Maddox, John Royden, *The Doomsday Syndrome* (New York: McGraw-Hill, 1972).

Mesthene, Emmanuel G. (ed.), *Technology and Social Change* (Indianapolis: Bobbs Merrill, 1967).

Mumford, Lewis, [2] *The Myth of the Machine* (2 vols.—*Technics and Human Development, The Pentagon of Power*) (New York: Harcourt, Brace & World, 1967, 1970).

Mumford, Lewis, *Technics and Civilization* (New York: Harcourt Brace and World, 1967).

Pacey, Arnold, *The Culture of Technology* (Cambridge, Mass.: M.I.T. Press, 1983).

Roszak, Theodore, *The Making of a Counter Culture: Reflections on the Technocratic Society and Its Youthful Opposition* (New York: Anchor Books, 1969).

Sanders, Donald H., *Computers in Society*, 3rd Edition (New York: McGraw-Hill, 1981).

Scheer, R., *With Enough Shovels* (New York: Random House, 1982).

Simon, Herbert A., *The Sciences of the Artificial* (Cambridge, Mass.: M.I.T. Press, 1969).

Spiegel-Rosing, I., and Derek de Solla Price, *Science, Technology, and Society: A Cross-Disciplinary Perspective* (London: Sage Publications, 1977).

Stanley, Manfred, *The Technological Conscience* (New York: The Free Press, 1978).

Susskind, Charles, *Understanding Technology* (Baltimore: Johns Hopkins Press, 1973).

Teich, Albert H. (ed.), [3] *Technology and Man's Future*, 2nd edition (New York: St. Martin's Press, 1977).

Trescott, Martha M. (ed.), [2] *Dynamo and Virgin Revisited* (Metuchen, N.J.: Scarecrow Press, 1979).

Weizenbaum, Joseph, [3] *Computer Power and Human Reason: From Judgment to Calculation* (San Francisco: W.H. Freeman, 1976).

Winner, Langdon, *Autonomous Technology: Technics-Out-Of-Control as a Theme in Political Thought* (Cambridge, Mass.: M.I.T. Press, 1977).

Women's Studies

Berk, Sara Fenstermaker, *Women and Household Labor* (Beverly Hills, Cal.: Sage Publishers, 1980).

Ehrenreich, Barbara, and Deirdre English, *For Her Own Good: 150 Years of the Expert's Advice to Women* (Garden City, N.Y.: Anchor Press/Doubleday, 1978).

Larcom, Lucy, *New England Girlhood* (New York: Corinth Books, 1961).

Robinson, Harriet Jane Hanson, *Loom and Spindle, or Life Among the Early Mill Girls* (Kailua, Hawaii: Press Pacifica, 1976).

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